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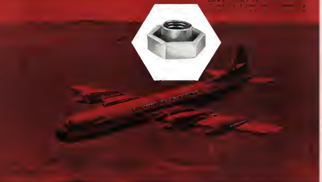

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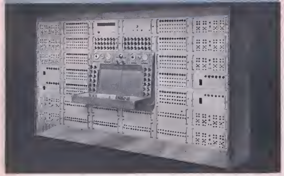

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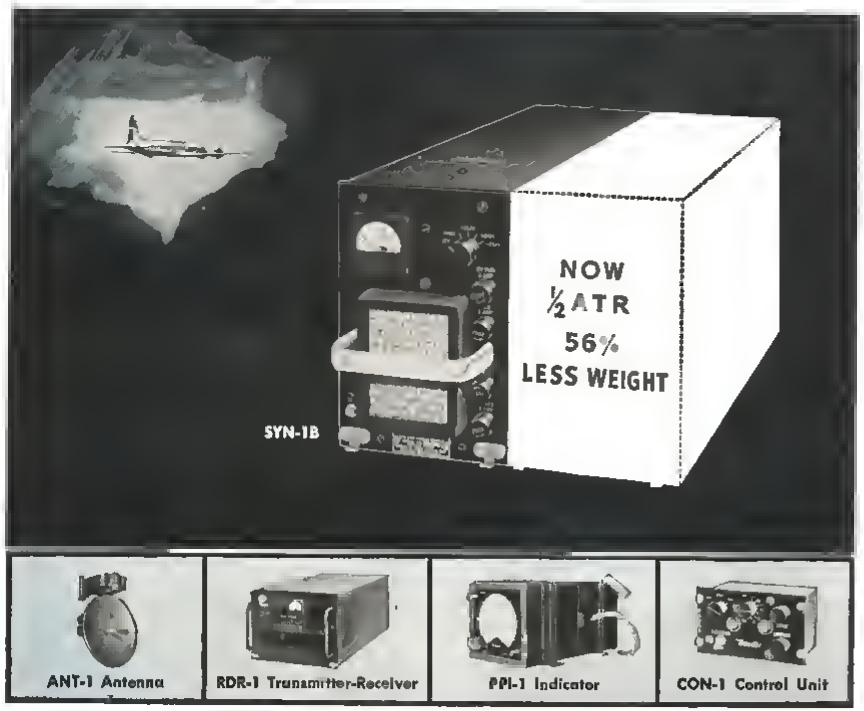

New . . . Lighter, Smaller Synchronizer For BENDIX Weather Radar System

This new SYN-1B Synchronizer—heart of the Bendix* RDR-1 Weather Radar System—represents the ultimate in lightweight design for this type of equipment. It weighs only 21 pounds—27 pounds less than its larger predecessor. The number of vacuum tubes used has been reduced from 32 to 19.

The SYN-1B Synchronizer is but one of several advancements incorporated in the Bendix RDR-1 Weather Radar System. Four types of antennas are available. Improved contour circuitry in the Transmitter-Receiver unit assures even greater trouble-free operation. All relays are protected against dust particles by easily accessible, removable covers.

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Canadian Distributor: Aviation Electric, 200 Laurentian Boulevard, Montreal, Quebec

Bendix AVIATION Radio

Bendix AVIATION CORPORATION

AVIATION CALENDAR

June 28-30—Institute of Navigation's 12th annual national conference. Hotel Miramar, Santa Monica, Calif.

June 30—Jet Age Conference, Sheraton-Jefferson Hotel, St. Louis, Mo.

July 7-10—Tenth annual All Woman Transcontinental Air Race (Powder Puff Derby). San Mateo County Airport, Calif. to Flint, Mich. Entries close June 30. For details write: Mrs. Betty M. Loufek, Lonfek & London, 2611 E. Spring St., Long Beach 6, Calif.

July 8—Third annual Western New York Air Show and Races. Niagara Falls Municipal Airport, Niagara Falls, N. Y.

July 15-30—World Parachuting Championship, Moscow, Russia.

July 31-Aug. 9—23rd Annual U. S. National Soaring Competitions, Aug. 5—Air Show. Grand Prairie Airport, Grand Prairie, Texas.

Aug. 1-5—Air Force Association's 1956 National Convention and Airpower Panorama. Roosevelt Hotel, New Orleans, La.

Aug. 6-8—Society of Automotive Engineers National West Coast Meeting. Mark Hopkins Hotel, San Francisco, Calif.

Aug. 15-17—Institute of the Aeronautical Sciences National Turbine-Powered Air Transportation Meeting. Grand Hotel, San Diego, Calif.

Aug. 21-24—Western Electronic Show and Convention. Pan Pacific Auditorium and Ambassador Hotel, Los Angeles.

Aug. 22-24—Bendix Aviation Corp.'s 1956 International Ignition Conference. Sidney, New York.

Aug. 27-29—Association for Computing Machinery. University of California, Westwood Campus, Los Angeles.

Sept. 9-11—International Northwest Aviation Council 20th annual convention. Boise, Idaho.

Sept. 10-14—American Society of Mechanical Engineers. Instruments & Regulators Div. Meeting. Detroit, Mich.

Sept. 16-22—American Society for Testing Materials Second Pacific National Meeting and Apparatus Exhibit. Hotel Statler, Los Angeles.

Sept. 17—International Air Transport Association 12th annual general meeting. Edinburgh, Scotland.

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Vol. 64, No. 26

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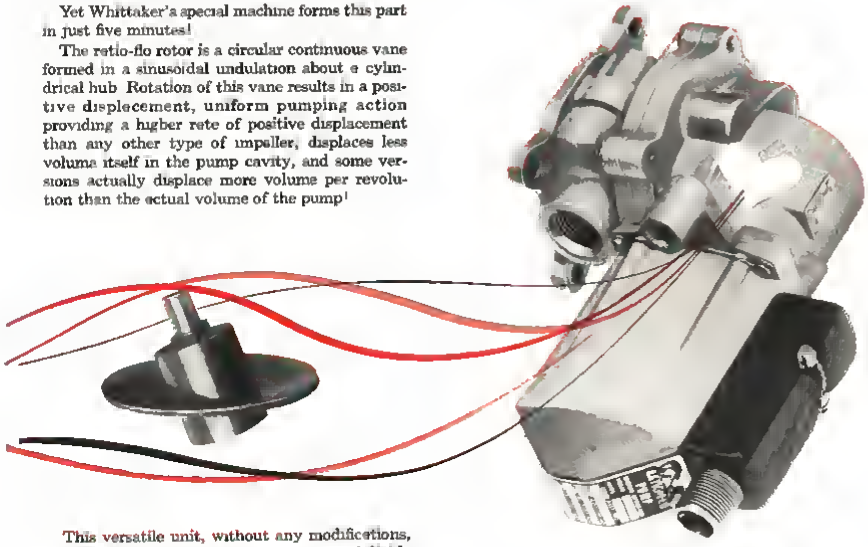
Why Whittaker Ratio-Flo Pump has a Five-to-One Advantage

The answer is the rotor—heart of the Whittaker Ratio-flo unit. Entirely new in concept, it has convolutions almost too complicated to define.

Yet Whittaker's special machine forms this part in just five minutes!

The ratio-flo rotor is a circular continuous vane formed in a sinusoidal undulation about a cylindrical hub. Rotation of this vane results in a positive displacement, uniform pumping action providing a higher rate of positive displacement than any other type of impeller, displaces less volume itself in the pump cavity, and some versions actually displace more volume per revolution than the actual volume of the pump!



This versatile unit, without any modifications, could divide two or more flows . . . pump and divide two or more flows. . .join two or more flows. . . pump and join two or more flows.

Your Whittaker Field Engineer can give you detailed information about these new fuel pumps, air pumps, flow joiners and flow dividers using the ratio-flo principle. Why not get in touch with him today.

Greatest advantage of the Whittaker Ratio-Flo pump is efficiency—in all cases over 80% as against the average pump efficiency of 15%. It draws constant current regardless of pumping rate, and current requirement is only about 1/3 to 1/5 as much as with a centrifugal pump

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the DOOR LOCK INDICATOR SWITCH

Hermetically-Sealed Limit Switch Chosen for Dependability in Any Environment

In today's modern aircraft, remote "fingers" tell when closures are properly "buttoned up" for high speed flying. This Electro-Snap Door Lock Indicator Switch is a typical example. It controls landing gear door position, lights an indicator on the instrument panel when doors are securely latched, and "cuts out" the door motor.

To match the all-altitude, all-temperature performance of the aircraft it serves, the switch is hermetically-sealed. Both electrical and mechanical parts are sealed in a dry, inert gas for dependable operation *in any environment*. Temperature cycling can't cause condensation inside the case; the switch can't freeze because all moisture is sealed out. Hermetic sealing protects the switch from dirt, corrosive atmospheres, oil saturation, tampering and mis-adjustment.

Characteristics remain constant from —100° F. to + 250° F.* The unique tapping-action actuator operates dependably even when the outside case is coated with ice.

It's little wonder that Electro-Snap Hermetically-Sealed Limit Switches are first choice on so many modern aircraft—for all kinds of switching jobs where dependability is a 'must'. For complete details about the many types available, see our catalog in Sweet's and send us a description of your requirements.

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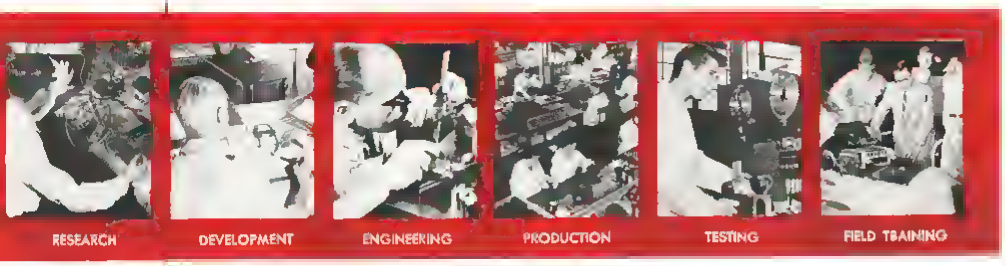

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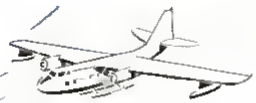

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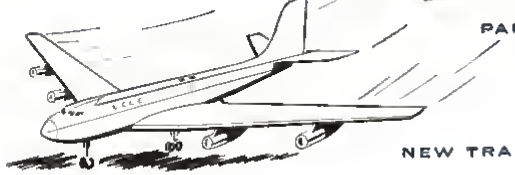

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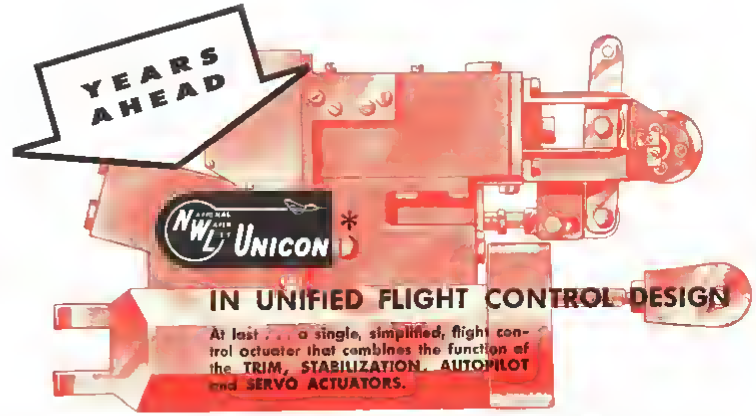

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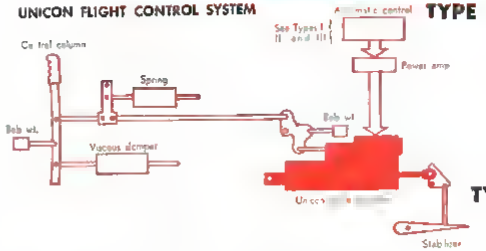

TYPE I

Integrates FLIGHT STABILIZATION and MANUAL CONTROL

UNICON I — Integrated hydraulic servo actuator links in series the automatic flight stabilization and pilot manual input signals

Fail safe provisions include pilot override by clutch limiting the authority of the stabilization system Optional pilot shut off is also provided

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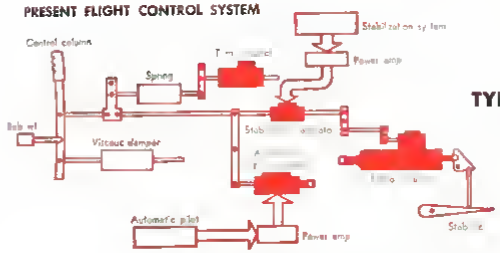
UNICON II — Integrated hydraulic servo actuator links in parallel the autopilot and manual pilot input signals

Optional pilot shut off and autopilot force limited override provides fail-safe system operation

PRESENT FLIGHT CONTROL SYSTEM



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Now, Satisfy Your Most Rigid Production Standards on Long or Short Runs

The Sciaky Predetermined Electronic Counter Weld Control employs a Dekatron tube to count the cycles of power line frequency and impulses of secondary current in predetermined absolute numbers and without deviation. Since power line frequency is maintained by reference to Naval Observatory time signals you get these same standards of accuracy with the new Sciaky Control Welder functions are *CENTRALIZED* — only one Dekatron tube is used to control succeeding functions such as "squeeze, weld, hold, and off".

The Sciaky Predetermined Electronic Counter Weld Control is absolutely consistent. Positive adjustment snap switch control dials are calibrated in cycles and impulses. You set the number of cycles and impulses you want and you get them throughout the longest or shortest run—and you can easily reproduce them at any time.

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Three of many different types in service: 1. Canopy seal regulator actuates mechanically by canopy movement—maintains pressure in inflated seal, but releases instantly for emergency escape. Auxiliary port provided for other uses. 2. Pylon tank regulator with relief valve, maintains constant pressure for fuel transfer. 3. High pressure anti-icing valve, regulates jet engine bleed air pressure for use in anti-icing systems.

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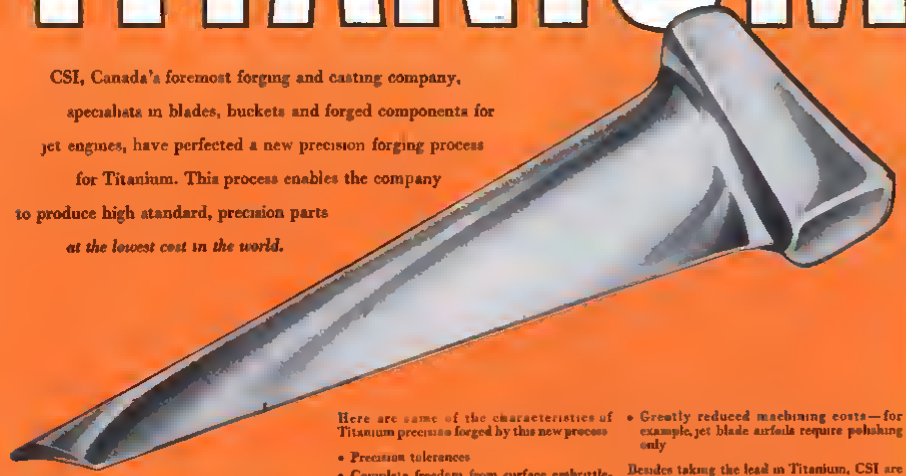

CSI, Canada's foremost forging and casting company, specializes in blades, buckets and forged components for jet engines, have perfected a new precision forging process for Titanium. This process enables the company to produce high standard, precision parts *at the lowest cost in the world.*

Here are some of the characteristics of Titanium precision forged by this new process

- Precision tolerances
- Complete freedom from surface embrittlement due to gaseous contamination.
- Excellent surface finish.
- Consistent quality maintained
- Greatly reduced machining costs—for example, jet blade airfoils require polishing only

Besides taking the lead in Titanium, CSI are also highly skilled and experienced in the production of high temperature alloy forgings and in forgings and castings of aluminum and magnesium.

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L. C. Leith, chief engineer, and [illegible] of Lear Inc., Grand Rapids, Mich. (left), and C. H. Brown, project engineer for flight controls, inspect the amplifier unit of the E-5 Autopilot system used in USAF jet fighters. The amplifier employs 27 of the total 40 G-E 5-Star Tubes installed in the Lear Autopilot.

40 G-E 5-STAR TUBES CONTRIBUTE TO RELIABILITY OF LEAR AUTOPILOT!

AUTOMATIC flight control must be fully dependable. To assure trustworthy operation of Autopilots under all flying conditions and at all speeds, Lear, Inc., relies on the superior performance and long efficient life of G-E 5-Star high-reliability tubes.

General Electric 5-Star Tubes are specially engineered and built for critical sockets. Shock-resistant design, precision manufacture, and exhaustive tests join to produce tubes that have top reliability and give long service even under extremes of vibration, temperature, and altitude that may be encountered.

These 5-Star Tube features add importantly to Autopilot reliability and have helped Lear gain recognition as a pioneer in the development and production of dependable flight-control systems.

Enjoy the same tube-performance benefits as Lear! Specify G-E 5-Star Tubes where reliability is vital! A wide range of miniature and sub-miniature types is available. *Tube Department, General Electric Company, Schenectady 5, N. Y.*

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JUNE 25, 1956

AVIATION WEEK

VOL. 64 NO. 26

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COVER Latest Navy jet aircraft fly formation at Naval Air Test Center, Patuxent River, Md.

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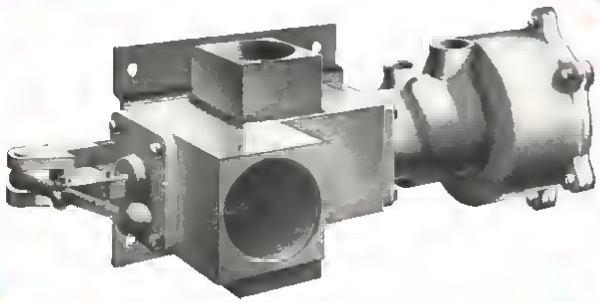

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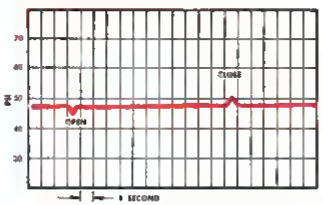

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EDITORIAL

Industrial Readiness and Airpower

(The Defense Department, under pressure from the Air Force, recently reversed its policy on reserve machine tools to permit utilization of modern equipment in current production. The modernized program now being implemented by the Air Force has been outlined by Dudley C. Sharp, Assistant Secretary of the Air Force, Materiel. Because of its importance to industry as a whole, Aviation Week is presenting significant extracts.)

The industrial readiness program represents our concept of the industrial conditions which are necessary to provide continuing superior American airpower. This program reflects the best and most useful things which we have learned throughout the years of preparedness planning with industry since World War II.

One of the most important parts of the industrial readiness program is directed toward our machine tool problem. We know that machine tool readiness is an essential foundation of industrial readiness. Machine tool availability is the keystone to our success in achieving timely production for new weapons or in expanding overall production.

I would like to bring you up to date on the status of our tools and to give you an order of magnitude impression of our total interest. Our present inventory consists of 145,000 machine tools with an acquisition value of approximately $1.4 billion. Of these, about 100,000 are in active use by our contractors, and the remainder is being maintained as reserve. Of these tools, approximately 60% are metal forming and metal cutting type tools produced by the machine tool industry. The balance consists of other types of capital equipment such as conveyors, foundry equipment and heat treating equipment. Our purchases, through our prime contractors as agents, are running about $200 million per year.

To modernize the inventory we are moving in two directions. First, we must strip the inventory of the obsolete and worn out tools which have served their economic and productive purposes. Along with these, we also will dispose of those special-purpose tools peculiar to products no longer being used. We estimate that this purging operation will reduce the inventory by 4,000 to 5,000 units in the next year.

The second area of modernization is to replace in the inventory those tools for which more advanced types exist which can yield significant increases in efficiency. These tools have been developed and are available in some of the larger metal working and metal forming items. Joint team work between your industry, the aeronautical industry and the Air Force has lead to the availability of many of these improved types.

We cannot, of course, expect to replace all of these tools on a short-range basis. We have set standards for the elimination of these tools based upon repair costs required to bring them to maximum efficiency. Tools bought prior to 1941 to 1946 and requiring 25% or more of their acquisition value for full repair will be disposed of. Tools bought after 1946 and requiring 35% or more of their acquisition value for repair will be disposed of. Against these criteria, we have placed an over-all repair ceiling of about $3,500 per unit.

Our initial program for this modernization has been authorized for approximately $70 million. We are currently carrying out the necessary reviews and analyses with industry to finalize the types and numbers of tools to be bought in subsequent years under the modernization program.

We are also, with our contractors, reviewing the inventory to develop all of the necessary comparative factors on efficiency, condition, remainder of life and economic benefits of replacement as a basis for future replacement purposes. This is being done on a progressive basis starting with the more complex high-cost tools and working down through those of lesser lead time and cost.

In order to determine the true dollar values of tool replacement, we advocate discarding the standard government practice of carrying capital assets on the books at acquisition value with no depreciation allowances. We favor the use of a declining balance rate of depreciation rather than the straight line method for total useful life. Our approach is based upon taking the greatest depreciation of the tool value for the first year of use. Under this method, the values are recomputed annually and the system generally results in writing the tool values off much earlier than by the outdated methods. This method is much more in keeping with modern industrial practice.

Supplementing the modernization program . . . We are vigorously supporting the development of more advanced type tools and equipment. We recognize that in many instances an adequate commercial incentive does not exist to warrant the investment of extensive high cost development efforts. The urgency and need for better production tools justifies our financial support of development of this type.

. . . The more radical of new weapons under development, such as the nuclear bomber and the ICBM, undoubtedly will require the production processing of new and different materials. At this point in time, we have not been able to establish the machine-tool impact for these weapons. The matter is under study and, as soon as adequate findings and data are available, very close cooperative work will be required among yourselves, the prime contractors and Air Materiel Command.

. . . One of the most promising advances in machine tools and production equipment appears to us to be in the area of electronics programming and director-control applications to production equipment. We have had some revolutionary results in the use of electronics for some of our more-complex structural parts.

For example, in the machining of a wing skin, it has been possible to reduce machine time from 130 hours per piece to 12.2 hours per piece. This saving has been possible by the transfer of human skill to electronically directed instructions and controls to the machine. When a machine operator sets up one of these pieces to perform his operations, he naturally is extremely careful and methodical in each step of his work. The necessity for him to work in several dimensions because of the compound curvatures demands painstaking and extremely time-consuming attention and control. We believe that electronics will ultimately replace this costly and time-consuming work . . .

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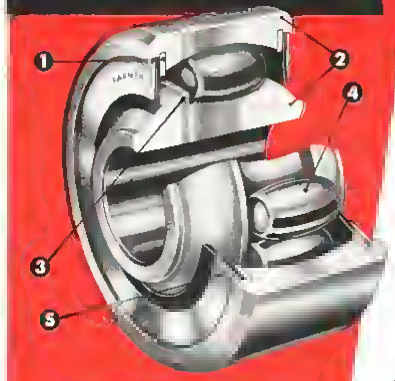

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DSRP4	.2500	.9014	.625	.464	.404	.065	.032	12	1514	3025	.65
DSRP5	.3125	1.2500	.812	.650	.515	.015	.032	11	.2203	7350	1.6
DSRP6	.3750	1.4275	.937	.750	.564	.015	.032	11	.2681	9500	.24
DSRP8	.5000	1.6875	1.000	.812	.775	.015	.044	12	.3023	12500	.36
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Jack Marler, vice president Pacific Aircraft Sales Co., Oakland, Calif.

H. J. McGinn, board chairman (and president) Eaton Manufacturing Co., Cleveland, Ohio. He succeeds **C. I. Ochs**, retiring as board chairman but retaining executive committee chairmanship. Also **Herbert S. Ide, Jr.**, administrative vice president treasurer; **Paul E. Musel**, vice president industrial relations, and **Raymond G. Heugst**, secretary general counsel.

Alexander Flax, vice president technical operations Cornell Aeronautical Laboratory, Buffalo, N. Y., succeeding **Will M. Duke**, resigned.

Air Marshal Sir Ralph Cochrane, in charge of Rolls-Royce, Ltd.'s nuclear research.

Dr. George J. Mueller, chief engineer Technical Products Division, Packard Bell Co., Los Angeles, Calif.

Robert S. Goodyear, president, Fenwal Electronics, Inc., Framingham, Mass.

William C. McFadden, executive vice president, Hycon Manufacturing Co., Pasadena, Calif.

James O. Burke, president Standard Coil Products Co., Inc., succeeding **Glen E. Swanson**, board chairman.

Arthur J. Loose, vice president, Vapor Heating Corp., Chicago, Ill.

Charles A. Sereno, executive vice president, Air Associates, Inc., Teterboro, N. J.

Honors and Elections

George T. Hayes, manager Washington, D. C. office of Stanford Research Institute, was elected to serve on the Daniel Guggenheim Medal Board of Award. He will be a representative of the American Society of Mechanical Engineers and will complete the unexpired term of the late **Ralph S. Damon**.

Brig. Gen. Leslie G. Mulzer, Commander of Dayton Air Force Depot received the National Safety Council's Award of Honor, which was granted for the depot's excellent ground safety record during 1955, and the King Reed trophy, given by AMC every three months to the Air Force Depot showing the most improvement in performance.

Changes

Joseph P. McNamara, manager Neosho, Mo., plant of Rocketdyne Div. of North American Aviation.

Julian R. Schrenk, research director Allegheny Airlines.

Ted C. Fisher, administrative engineer, **Herbert N. Reitz**, senior project engineer, Hamilton Standard, Division of United Aircraft Corp., Windsor Locks, Conn.

Frank C. Hobbs, general manager economic control, Trans World Airlines.

INDUSTRY OBSERVER

►Warhead and re-entry body of the intercontinental ballistic missile will be the first items to undergo tests in the supersonic wind tunnel at the USAF's Arnold Engineering Development Center in Tullahoma, Tenn. The tunnel is scheduled to begin operations in 1959.

►**President Eisenhower's Fiscal 1957 budget calls for the expenditure of $582,843,000 towards the ICBM's development; the Fiscal 1956 figure was $421,880,000, Fiscal 1955's, $179,575,000.**

►BOAC probably will miss its new Aug. 1 target date for inaugurating Bristol Britannia service. A modified Britannia on recent trials in Africa failed to prove that the difficulties of the Proteus engine resulting from icing conditions had been eliminated. The Proteus had been flaming out from slush sucked through the intake during de-icing (AW May 14, p. 30). The Britannia is back in England and further modifications are planned.

►**Ryan X-13 will make its first vertical landing and takeoff within the month. All takeoffs made thus far have been from a normal attitude through the use of a jury rigged landing gear.**

►Planned construction of seven Nike installations in Alaska has been postponed, probably as a result of the Army-USAF controversy over the missile's effectiveness.

►**General Electric J79 engines for Convair's Skylark 600 medium range jet transport will be equipped with GE sound suppressors and thrust reversers. Overhaul time on the J79 will be about 500 hours when they go into service on the Skylark, but eventual overhaul period is expected to be between 1,200 and 1,400 hours.**

►New Free German Air Force is expected to establish its own equivalent of the Air Research and Development Command at Koblentz. Work already is under way on a parachute study.

►**General Electric has bailment F-101A Voodoo for installation of J79 engines on a test basis. Plane is now fitted with two Pratt & Whitney J57s.**

►Vertol is developing new rotor blades for the H-21 made of fiber glass instead of wood because of problems encountered with the first H-21s to go into service with the French Army. Source of the trouble stems from erosion caused by sand in Algeria where the aircraft are in operational use.

►**Continental Airlines has picked up an option on five additional Vickers Viscount 840s. This confirmed order for mid-1959 delivery will raise Continental's Viscount fleet to 20 aircraft.**

►Current production rate of Dassault Mystere 2 and 4 aircraft is 35 per month, comparable to some American numbers. Planes are made on a moving production line at the Merignac plant near Bordeaux with a work force of only 1,125 persons. Dassault has produced more than 1,000 aircraft since its rehabilitation in 1946.

►**German electronics industry is almost ready to break into the Mutual Defense Aid Program with two items that have been accepted as qualified products. While their work is considered excellent, most German firms are reluctant to adopt many U. S. standards.**

►U. S. aircraft industry may be requested by USAF to keep translation problems in mind when drawing up airframe and engine specifications. Misleading translations sometimes are to blame for inability of European manufacturers to qualify their products.

►**European procurement program under the Mutual Defense Aid Program is handicapped by a lack of experienced USAF officers. Less than 12% have had depot experience prior to their overseas assignment.**

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WASHINGTON ROUNDUP

Airpower Showdown

Defense Secretary Charles E. Wilson, Army Secretary Wilber M. Brucker, Navy Secretary Charles S. Thomas and Air Force Secretary Donald A. Quarles will be confronted in open sessions this week with the comprehensive testimony of military leaders on the inadequacies of airpower. Brucker, Thomas and Quarles will appear before the Senate Airpower Investigating Subcommittee today and tomorrow. The subcommittee, headed by Sen. Stuart Symington (D.-Mo.), will wind-up its investigation in public session with Wilson on Friday. Testimony of the military leaders has been gathered in executive sessions held over the last several months.

An Invitation for Wilson

Secretary of Defense Charles E. Wilson and heads of all three services will be invited to attend House Information Subcommittee hearings on military information and security policies. The subcommittee, headed by Rep. John E. Moss (D.-Calif.), also is considering calling Trevor Gardner, former Assistant Secretary of the Air Force for Research and Development.

Presumably, Gardner would be asked whether secrecy policies have hampered technological progress. Hearings now have been tentatively set for July 5 and 6 and for July 9 through July 13.

The subcommittee will look into conflicts between military censors and personnel of Commerce Department's Office of Strategic Information (AW Jan. 30, p. 9).

Military security officers say OSI, an office created to deal with unclassified information, has tried to tell them what not to release and has used the prestige of the National Security Council, which was responsible for its organization, as a means of pushing its own arguments.

Traffic Control Outlook

Hopes for a true common system approach to the pressing air traffic control problem have been raised by the fact that thinking of Civil Aeronautics Administration, Air Force, Navy and Air Navigation Development Board is closer together than at any time in the past six years.

The close liaison between CAA's Technical Development Evaluation Center and USAF's Traffic Control and Land System (TRACALS) project office is partially responsible for ironing out previous differences in philosophy.

Murphree Satisfied

Defense Secretary Wilson's special assistant for guided missiles reports that he has found his job much less difficult than he, and most experts, had originally anticipated. Eger V. Murphree, named to expedite the apparently muddled intercontinental and intermediate range ballistic missile programs, now says:

"I have found no case where availability of funds was holding up progress on these missiles and, except for very minor instances, I have also found no case where administrative red tape was hindering progress. The only limitation on progress that exists is the time that it takes to solve technical and engineering problems, which in many cases represent extensions of the known art."

On the subject of the Army-Air Force controversy over the relative merits of the Nike and Talos missiles, Murphree said their relative merits are under study and that he finds it "very comforting to have two such fine missiles under development."

Independent MATS

The Senate Appropriations Committee has given the Air Force the green light to move ahead with its plan to set up the Military Air Transport Service as a self-supporting, semi-independent organization, with this instruction:

"The Department of Defense should, in the future, utilize the services of commercial transportation to the fullest extent possible when it is more economical, and in evaluating relative costs of transportation, the department should recognize the element of time saved as an important factor."

Re-Equipment Financing Hits Snag

Legislation that would permit subsidized air carriers to set aside profits on the sale of aircraft for the purchase of new equipment—without having the profits deducted from their subsidy allocations—has run into the firm opposition of economy-minded Sen. John Williams (R.-Del.).

Sponsors of the legislation, led by Sen. Alan Bible (D.-Nev.), argue that, in the long run, it will save government funds. With modern equipment, they say, air carriers will have lower subsidy requirements.

Williams, on the other hand, says the measure would only increase subsidy payments. He wants a stipulation in the legislation that the subsidy allocation of all carriers utilizing the set-aside automatically be reduced by at least 25%.

Williams reported that a computation by the Commerce Department shows that, if the legislation had been in effect over the last five years, the government's airline subsidy bill would have been $22 million above the present figures. Of the total, according to the computation, $17.3 million would have gone to Pan American-World Airways, $1.3 million to Trans World Airlines and $1.5 million to Braniff Airways.

Trippe's 'Pink Tea Party'

Pan American-World Airways with President Juan T. Trippe on the stand slipped through the airline hearings of the House Anti-Trust Subcommittee without the expected fireworks. Previous hearings held in the months-long investigation into airline operations indicated that the group would be laying for Pan American, but Trippe blunted committee attacks and managed to use the hearings to argue some of PAA's favorite points.

Trippe denied implications of any monopolistic activities on the part of Pan American and told the House group that competition facing Pan American makes domestic airline operations look like a "pink tea party." He used the committee hearing to plead for a New York-Florida route for his airline, and he put in a plug for a third-class transatlantic fare, estimating that such a plan would increase passenger volume by 50%.

—Washington staff

Defense Endorses Limited Budget Hike

Administration approves $500 million USAF budget boost; Senate group wants $1.3 billion.

By Katherine Johnsen

Washington—The Administration last week agreed to another boost in Air Force funds for Fiscal 1957, an additional $350 million for aircraft procurement and $100 million for research and development.

The proposal was sponsored in the Senate by three Republican leaders—Sen. Styles Bridges (N.H.), Sen. Leverett Saltonstall (Mass.) and Sen. William K. Knowland (Calif.)—in an overnight move to counter strong Senate support for a still larger increase.

On the day before, the Senate Appropriations Committee had voted 13-to-12 for an increase of $800 million in USAF procurement funds and $100 million in research and development funds. This action was supported by ten Democrats, led by Sen. Dennis Chavez (D-N.M.), and three Republicans. It was opposed by nine Republicans and three Democrats.

Administration Endorsement

Offering his proposal for a total $500 million increase in USAF's budget (including $350 million for procurement and $100 million for research and development) over the amount approved by the House, Bridges reported that he was doing so with the "knowledge" of the Department of Defense and added:

"I have a belief that if this proposal is adopted ... the Administration and the Department of Defense will endeavor in good faith to make use of the money."

The Bridges proposal also was co-sponsored by the three Democrats on the House Appropriations Committee who voted against a total $1.3 billion increase in USAF's budget (including the $800 million for procurement and the $100 million for research and development). They were Sens. Allen Ellender (La.), Spessard Holland (Fla.), and Harry F. Byrd (Va.).

Without Administration support, congressional increases in appropriations are ineffective. The Administration simply impounds—or fails to use—funds.

As compared with the $15.5 billion voted by the House, the three proposals for USAF's Fiscal 1957 appropriation up for action on the Senate floor this week are:

Proposals Before Senate

- **Administration's formal** recommendation: $15.7 billion. This includes the $376.5 million supplemental request submitted in April, which included $248 million for B-52 production. The House trimmed the budget by almost $190 million.
- **Senate Appropriations Committee's** recommendation: $16.8 billion. This is $1.3 billion more than approved by the House and $1.1 billion more than the Administration's formal proposal.
- **The Bridges proposal**, which now has Administration support: $16 billion.

USAF's Fiscal 1956 appropriation was $14.7 billion.

However, even the additional $800 million for plane procurement and $100 million for research and development voted by the Senate Appropriations Committee, fail to meet the requirements which USAF's military commanders consider essential.

- Gen. Curtis LeMay, commander of Strategic Air Command, reported to the committee that an additional $1.8 billion is necessary for SAC alone if it is to keep abreast of Russia in long range bombing capability (AW June 18, p. 26).

The Appropriations Committee stipulated that its $800 million increase is to be used "primarily for increasing the production of heavy bombers for SAC," but that "should it be deemed advisable, part is available for increased production of fighter aircraft for the continental defense."

- **Lt. Gen. Donald Putt,** Deputy Chief of Staff for Research and Development, recommended an increase of $250 to $300 million in research and development funds for Fiscal 1957 in congressional testimony (See page 27). The $100 million recommended by both the Senate Appropriations Committee and the Bridges group seems assured of adoption.

In May, the House overwhelmingly voted down a proposed $1 billion increase in procurement funds for SAC. They gave two reasons—that additional B-52s would be of little value to SAC without supporting bases and personnel and that the Administration would not use the funds, even if they were appropriated.

How Will House Vote?

Indications now, however, are that the House probably will go along with any increase in procurement or research and development funds voted by the Senate.

Since its original vote, Gen. LeMay has proposed a $3.8 billion increase in SAC's budget for additional B-52's and KC-135 tankers as well as supporting personnel and facilities. Putt's protest over the lagging research and development program has been widely publicized. And, finally, key Administration Senators now favor some increases.

The Senate Appropriations Committee approved the $2.5 billion voted by the House for Naval Aviation, slightly less ($2.6 million) than the Administration's request. Of the total, $1.7 billion is for aircraft and related procurement—almost double the $906 million for the current Fiscal 1956 year.

The $800 million increase recommended by the Senate Appropriations Committee would bring the USAF's total aircraft procurement appropriation for Fiscal 1957 to over $6.8 billion—$543 million more than for Fiscal 1956.

The $100 million increase would give the USAF $710 million in new research-and-development money for the coming year—$140 million more than for Fiscal 1956.

Aviation Week at Russian Air Show

A comprehensive, first-hand report on the Russian air show being attended by Gen. Nathan F. Twining, USAF chief of staff, and top Air Force research-and-development experts will be published by Aviation Week in its July 2 issue.

The show, scheduled for yesterday in Moscow, is being covered by Aviation Week Editor Robert B. Hotz and extends the magazine's on-the-spot coverage of the world's major air shows to behind the Iron Curtain. Shows already covered on an annual basis include the SBAC show in Farnborough, England, France's Paris Air Show and the National Aircraft Show in the U.S.

General officers attending the Russian air show with Gen. Twining include Lt. Gen. Donald L. Putt, deputy chief of staff for research and development, Lt. Gen. Thomas S. Power, commander of the Air Research & Development Command, Maj. Gen. Al Boyd, deputy commander of ARDC for weapons systems, Lt. Gen. Frank F. Everest, deputy chief of staff for operations, Lt. Gen. Clarence S. Irvine, deputy chief of staff for materiel, and Brig. Gen. William H. Blanchard, deputy director of operations, Strategic Air Command.

When Bridges offered his compromise proposal after voting against the original measure, Sen. Lyndon Johnson (D.-Tex.), chided:

"I wish to congratulate the Senator on improving his position at least $500 million overnight. I wish to congratulate him on getting the administration to go along with that position. I wish to congratulate him on the progress he has made."

Here's how Sen. Dennis Chavez (D.-N.M.), chairman of the Appropriations Committee, explained the group's increase in USAF funds to the Senate:

"We were only trying to do what the military wanted to have done. If those men had not been afraid to talk in front of the white-collar workers of the Bureau of the Budget and the Pentagon who were listening to them, they would have told us the truth. Even Gen. Nathan Twining, Air Force chief of staff, speaking about the recommendation of the Budget Bureau, very coyly said that this is an austere USAF budget. What he really wanted to tell us was that it was not enough. But he was working under orders . . .

"I know the practice which is followed. They tell us in private that they want $1 billion more, but they do not dare say so before the committee, because somebody is watching and listening to them.

"But who will take care of the nation when a war comes? Will it be the the white collar men in the Pentagon? Will it be the Secretary of Defense or the assistant secretaries? Or will it be the LeMays, the Twinings, the Burkes and the Taylors?"

Senate Group's R&D Boost Falls Short

Washington—The $100 million boost to Air Force research-and-development funds approved by the Senate Appropriations Committee last week (see page 26) still falls far short of the USAF's minimum and critical needs outlined by two of the nation's top R&D experts.

In testimony made prior to the Senate committee's action, Lt. Gen. Donald Putt, deputy USAF chief of staff for research and development, told the Senate Air Power Investigating Subcommittee that an additional $250 to $300 million in research-and-development funds is needed for Fiscal 1957.

Trevor Gardner, former assistant secretary of the air force for research and development, testified under oath before the same subcommittee, headed by Sen. Stuart Symington (D.-Mo.), that his mid-February resignation stemmed from a flat turn down of his request for an additional $200 million in R&D funds for Fiscal 1957.

In the formulation of research-and-development budgets, Gardner told the subcommittee, "The Secretary of Defense dictated a figure, a flat ceiling, which none of us were able to break. Over the past year, he said, development of DEW (Distant Early Warning Network) and SACE (Semi-Automatic Ground Environment) systems have been delayed for lack of funds. Instead of the present program for one Texas tower off Boston, there is a requirement for five, he said.

Where R&D Lags

Gardner said that Secretary of the Air Force Donald A. Quarles was responsible for the establishment of ceilings on the USAF's research-and-development program during his tenure as assistant secretary of defense for research and development. Quarles served as assistant secretary from September 1953, until he replaced Harold Talbott as secretary of the Air Force in August 1955.

Gen. Putt testified that, above and beyond the needed $250 or $300 million, the USAF's research-and-development effort required an additional $50 to $100 million for supporting facilities.

He listed these areas in which the USAF research-and-development program is lagging:

- **Missile defense.** USAF's request for $344 million which "could be profitably used in work on a project for direct defense against long range ballistic missiles," he reported, has been cut to $2 million for Fiscal 1957. He said that this cut would "significantly delay development" on the defense counter weapon.
- **Missiles.** With additional funds "our work could have progressed faster almost across the board in the field of missiles. The Snark program has been stretched from time to time. We could have used additional funds wisely in the Navaho (intercontinental) program.

The (air to air) Falcon program has probably not suffered to the same extent." Work on penetration missiles under the Fiscal 1957 budget, he said, "will be stretched over what we could do.

- **B-52 successor.** The USAF "will not have sufficient funds" for research and development work on a possible successor to the B-52 under the Fiscal 1957 program. For one project (presumably, the chemically-powered bomber) there will be "less than half the requirement." For the other project, the nuclear aircraft, there will be $20 million available as compared with a requirement of $112 million.
- **Aircraft weapons systems.** Because of lack of funds, "the initiation of some systems have been delayed—such as a new tactical bomber. We have delayed work on strategic bombers." On the nuclear aircraft project, he said, work was initially delayed on the propulsion system and later on the airframe and sub-systems.
- **Research aircraft.** Of USAF's requirement for $19 million for research and development on the high-altitude X-15, only $8 million is programmed for Fiscal 1957.
- **Radar.** Lack of funds "is restricting" several areas of radar research and development. However, because of the high priority given in allocation, there will be "adequate" funds for Fiscal 1957 research and development on large, heavy radars for detection and warning against an incoming Russian intercontinental ballistic missile.
- **Electronics systems.** Work has been delayed on programs to produce more reliable avionic systems. "While it might sound like a rather minor element, relatively low in cost, it is vitally important because the mission of a B-52 that costs roughly $8 million will have to abort because of the sloppy two or three electronic components," he explained.
- **Propulsion.** "Practically all of our propulsion work in jet engines has been stretched out beyond what could have been accomplished with additional funds."
- **Earth satellites.** Gen. Putt placed the USAF's requirement at $39 million for work in this area and added: ". . . We have zero dollars for this project in Fiscal 1957." No work will be done he added, "except with such funds as may be earned over from Fiscal 1956."
- **Fuels.** Research on high energy fuels, which show "great promise of substantially increasing the range of existing aircraft, could be expedited" if sufficient funds were available.
- **Boundary layer control.** To illustrate the "dramatic results" possible from research in this field Gen. Putt said that, theoretically, the weight of the B-52 could be reduced from 400,000 lbs. to 90,000 lbs., opening the way for major improvements in military performance.

USAF's request for boundary layer control he reported, was originally $5.7 million. It was cut to $1 million.

- **Materials.** For "almost anything you can mention," Gen. Putt told the subcommittee, "materials are a large limiting factor." USAF's $7.4 million program for Fiscal 1957, he said, "is about 85% of what we think should be going

into materials research and development."

• **Technical studies.** For Fiscal 1957, he said, "The money for technical studies which would have a great influence on our programs for 1958, 1959, and beyond are reduced to practically zero."

The general re-emphasized that the rate at which Russia is closing the gap of U S air superiority presents the Air Force with its gravest problems. He specified that in the three major areas—engines, airframes and radar—the U S has a substantial lead at present but that Russia today "has enough scientific, technological and industrial capacity to achieve and face us with a technological surprise."

Following are Gen Putt's appraisal of the U S lead in these fields

• **Engines.** "I would think at the present time in the general state of the art—and this covers a lot of fields of technology that go into the manufacture of jet engines—that we are ahead."

• **Airframes** "Particularly in structures and in basic aerodynamics as of today" the U S has the lead. "Again I am worried at the rate that they are catching up."

• **Radar** The U S has a "measurable lead," but the "Russians have demonstrated a rather remarkable capability to produce some first-class radar equipment, particularly when one considers that their native ability . . . at the end of World War II was very meager, if any."

Killian Tells Senate Committee 'New Flexibility' Needed in R&D

By Claude Witze

Washington—The Defense Department's research and development budget needs new flexibility, "A reasonable compromise between necessary fiscal prudence and the requirements" This advice was given the Senate Airpower Investigating Subcommittee last week by Dr James R Killian, Jr., president of the Massachusetts Institute of Technology and one of the Administration's top scientific advisors

The Defense Department budget, Dr Killian said must recognize that changes in technology frequently force changes in strategy

"I think I should go so far," he said, "as to say that the fundamental requirement for a sound budgetary policy for R&D is the maintenance of flexibility to encourage further innovation, to pick up the new and bright ideas as they come along to create a climate where men in the R&D establishments will not be reluctant, discouraged or unreceptive when they see new ideas and new projects that need help and sponsorship."

Other suggestions by Dr Killian

• **Stronger co-ordination** at the policy-making levels First step should be congressional approval of a proposal to give each of the armed services its own Assistant Secretary for Research and Development with an adequate staff of scientists and engineers

• **Better use of advances** in basic research made at universities and other institutions where radical approaches to weapons system improvements are more likely to appear than in the military establishments

• **A firm procedure** for favoring high priority projects, dropping others where possible. "The smart men want to be associated with the projects of greatest significance and challenge Too rigid and too centralized budget control can work against this kind of adjustment."

• **Increased opportunities** for discretionary allotment of funds at the working level

• **A larger R&D budget.** "We must recognize that people who buy and do R&D are bound to make mistakes and go down some blind alleys Some ideas and projects will not pay off. . . . In research it is dangerous to be afraid to fail"

In a discussion of Russian technological education, Dr. Killian told the committee, headed by Sen. Stuart Symington (Dem.-Mo.), that the Soviets have a larger supply of professional scientists and engineers from a smaller total school and university population, than the United States

In the critical areas, he continued, the quality of these professionals is first rate

The Soviet educational system was criticized by Dr Killian as limited and too specialized. He added, however, that the use of this talent within the Soviet system permits concentrated attack on any given problem and "has had its obvious successes."

In the field of aeronautics, Dr Killian said an MIT study shows that Russia has a small but elite corps of top scientists who have solved problems carefully selected to keep the Soviet's aeronautical-science level abreast of any competitor. There are cases, he reported, where superior designs get inferior execution But, then he warned

"It is one thing to recite that Soviet automobile production is only between 1 and 2% of ours it is quite another to understand that her production of machine tools now exceeds ours."

Dr Killian made a strong plea for more university-level scholarships to stop what he termed America's waste of talented young people who fail to get a college education Pointing out that a third of the top 2% of U S high school graduates receive no higher education, he estimated that 200,000 potential leaders are bypassed each year

The scientist-educator said he preferred to have industry provide the necessary scholarship help If this cannot be done, he added, there should be a federal program providing for as many as 9,000 scholarships annually

A critical weakness in this field, Dr Killian said, is the diminished interest in science and mathematics He said the U. S is "perilously close to becoming a nation of mathematical illiterates in a period when mathematics is an essential ingredient of airpower."

For the aircraft industry Dr Killian recommended a larger expenditure for basic research with provision for supporting that effort in military procurement contracts

Technology Outstrips Perception

Washington—Defense Department personnel, in uniform and out, generally lack "the capacity to visualize and direct the integration of complicated technological systems" in the opinion of Dr. James R Killian, Jr., president of Massachusetts Institute of Technology The problem of systems integration within the three military services, he said, 'is one of the major problems affecting the security of the United States."

In testimony before the Senate Airpower Investigating Committee, Dr. Killian continued:

"I do not suggest that this means complete unification of the three services. I do suggest that in dealing with air defense, with intercontinental ballistic missiles and other great weapons systems, we must create the organizational patterns which will make it possible, first, effectively to develop them without wastage of manpower and resources and unprofitable duplication of effort, and secondly, to manage them in terms of their wholeness as systems.

"So far we have not been able, in the definition of the roles and missions of the services, to keep pace with evolving weapons systems' technology, and, as a consequence, we lengthen out lead time, we make more difficult our decision-making processes, we needlessly increase costs and we find it difficult to avoid friction and duplication of effort

"I do not minimize the difficulty of achieving this greater degree of integration, and I speak of its importance not to criticize existing practices but to urge a growing recognition of the fact that a revolution is upon us . . . I cannot escape the feeling that events of the technological age are moving faster than our perception of their meaning, either in industry or government, and that we need more carefully to tune in our receivers to pick up the changes which lie ahead."

Air Force Explains H-Bomb Drop Error

Washington—The USAF admitted reluctantly last week that it missed the target by almost four miles in the hydrogen bomb test over Bikini on May 21. The reason human error

The Air Force admission came after news of the inaccuracy was published by a Honolulu newspaper

USAF Secretary Donald A Quarles then said the error stemmed from the "manipulation of the bombing equipment and did not involve malfunction of the aircraft or any of the equipment which it carried."

Actually, an error of as much as four miles was not unexpected, because the bombing technique used with a nuclear weapon is admittedly a compromise with accuracy, one worked out to insure the safety of the Boeing B-52 jet-bomber crew

For the bomb run, the aircraft approaches at maximum altitude and noses down to hit maximum speed At a predetermined point, it is put into an Immelman turn, pulling exactly 4 Gs The weapon is released automatically at the right point in the upward curve

The system permits the aircraft to be 20 miles (slant range) away at the time of detonation

The crew of the B-52 at Bikini was from Kirtland AFB, New Mexico, where an investigation was under way last week. Col Edward Walker chief of staff at the Special Weapons Center said the crew agreed with Quarles that human error was responsible and that they were unhappy about the incident

Meanwhile, a new group of atomic and security chiefs were headed for the Pacific to witness the experimental explosion of a hydrogen warhead for long-range missiles Lewis L Strauss atomic energy commissioner headed the party

Other members were Allen W. Dulles, chief of the Central Intelligence Agency, and Harold E Stassen, disarmament aide to the President.

Piasecki Aircraft Gets on Feet With 9 Prime, 45 Subcontracts

Philadelphia—Piasecki Aircraft Corp., formed scarcely one year ago after Frank N. Piasecki lost operating control of his original firm, seems well on its way to success

The 36 year-old Piasecki, former president and board chairman of what is now Vertol Aircraft Corp, reported last week that his new firm has received nine prime contracts, most of them for research and development work and 45 subcontracts

The company now has 90 employes at its International Airport plant, according to Piasecki, and is still hiring. Piasecki refused to list all the contracts on the grounds of military and proprietary security

New Contracts

These, however, were disclosed

• **For the U S Army,** Piasecki will design, manufacture and test a new helicopter rotor The goal is to reduce vibration, cut initial and maintenance costs and simplify design The rotor will eliminate parts in the blades and attachment mechanism and 80% of the hinge bearings Designed as a replacement for the rotor in the Vertol H-25 helicopter, it will be adaptable to other rotary wing aircraft

• **For the U S Navy,** Piasecki will develop a rug wing propeller combination for vertical lift Piasecki refused to give details on this project but it was understood that it is a type of flying platform, possibly capable of converting to horizontal flight Value of the contract is in excess of $94,000

• **For USAF** Piasecki will perform repair and overhaul on 120 sets (360) blades for the Vertol H-21 helicopter Contract awarded by the Middletown AMA amounts to $71,005 20

• **Also for the Navy,** the firm will design and develop a drone helicopter, presumably for anti-submarine warfare

• **For the Army,** Piasecki is working on a contract amounting to approximately $20,000 for overhaul and repair of blades for the Vertol H-25 helicopter

Subcontracts

Piasecki said his firm will use a surplus HRP helicopter purchased from the Navy and plans to construct a new test stand

Among the companies for which Piasecki said he is doing subcontract work are General Electric Westinghouse E G Budd Co and Martin Aircraft

Pattern of Piasecki's new venture follows closely the history of Vertol, formerly Piasecki Helicopter Corp., from which he was ousted as president, board chairman and board member in a bitter management fight that culminated in an acrimonious stockholder's meeting six weeks ago

Piasecki Helicopter Corp was started during World War II and subsisted in its early days on subcontract work until Piasecki interested the Navy in the first successful tandem helicopter At that time, capital was provided by Lawrence Rockefeller and A Felix du Pont, and the company became a success

In 1953 the Rockefeller interests brought in Don R Berlin as president Later Piasecki was removed as board chairman He immediately left his active position in the firm and started PAC The old company changed its name to Vertol

Piasecki Aircraft Corp., occupies four buildings at International Airport, all leased from the city of Philadelphia Total floor space is in excess of 24,000 sq ft In addition, the company has about 60,000 sq ft of ramp space

Associated with Piasecki in the new firm are several of his former associates at Vertol

Napier Gazelle Slated For Wessex Helicopter

Napier Gazelle gas turbine engine will be used to power the Wessex helicopter which Westland Aircraft Ltd., will put in production soon The helicopter is the Sikorsky S-58 built under license

Sikorsky version is powered by a Wright R1820 84 engine Wright-powered model was sold to Westland by Sikorsky and Sikorsky understanding was that Wright model will be evaluated by Royal Navy, for which craft is designed Napier engines are to be installed after this evaluation, Sikorsky says Sikorsky is to receive General Electric T 58 turboshaft engine for installation in S-58 model this summer (AW June 4, p 60)

Performance of Wessex given by Westland specifies maximum sea level speed of 115 kt., cruising speed of 110 kt at all-up weight of 12,600 lb Rate of climb will be 1,350 fpm with full load and range 382 nautical miles.

Empty weight is 7,259 lb Internal freight load capacity is 2,000 lb and external sling load 4,000 lb. Hovering ceiling in free air is 4,500 ft., with ground effect 8,400 ft. Cruising ceiling is 6,000 ft Main and tail rotors have four all metal blades

Craft eventually may be available for civil market, Westland says

Rocket Sled Passes Mach 2 in Test

FIVE ROCKETS push Convair designed rain erosion test sled to 620 mph in first 950 ft of run down 10,000 ft. dual-rail track at Edwards Air Force Base Test Center.

A rocket sled to test rain erosion on aircraft and missile parts has exceeded Mach 2 three times at the Air Research and Development Command's Flight Test Center, Edwards AFB, Calif.

Designed and built by the Convair Division of General Dynamics Corp. and powered by a dozen 11,000 lb. thrust Aerojet-General Corp. rockets, the test vehicle completes its run along a 10,000-ft. dual rail track in 6.7 sec. It first reached Mach 2 on April 25. Previous record for rocket sleds also set at Edwards, was 1,280 mph.

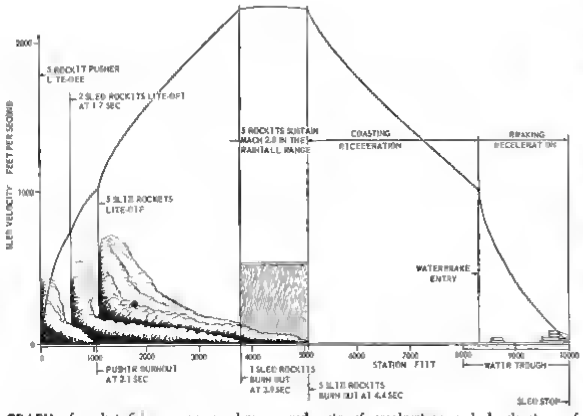
A complete section of an aircraft or missile can be run through a spray equal to approximately eight inches of rainfall per hour.

The part being tested remains in the spray only a half second, but with the volume of water used, the run is equivalent to approximately 16,500 ft. of one-inch rainfall at Mach 2.

Five rockets propel the vehicle's pusher to 620 mph in the first 950 ft. Two knife edges on the sled then cut a bronze screen on the track, breaking a circuit and sending 600 volts through a line to ignite the other seven rockets.

The sled reaches the spray at 3,800 feet. Its rockets burn out at 4,000-4,500 ft., but momentum carries it through the 1,200 ft. of spray at Mach 2.

The carefully controlled "rainfall" comes from nozzles erected on poles alongside the track. At 8,000 ft., a water brake takes hold, bringing the sled to a stop only 200-300 ft. from the end of the track. The pusher and sled ride on steel "slippers."



GRAPH of rocket firing sequence shows speed, rate of acceleration and deceleration of 800 lb. test bed. Five solid fuel rocket pusher starts run at ground zero. Seven sled rockets then light off. Tests above Mach 2 are planned in next few weeks.

TELEMETERING equipment is packed in 5½ in. dia. tube.

SLED is looked over by Brig. Gen. J. S. Holtoner, commander of the Edwards Air Force Base Test Center (left), Robert King (center), Air Force supervisor of the rocket track, and Roy Holmes, Convair Thermodynamics engineer who helped design sled.

DOZENS of these 6 ft. spray strands spaced along a 1,200 ft. section of the 10,000 ft. track provide test rainfall. Convair engineer F. R. Sedlund checks rainfall setting with a pressure gage. Water is supplied from tank on top of 100 ft. tower.

ARDC Science Meet

Prizes will be awarded for the three best papers presented by military or civilian scientists or technicians at the fourth annual Air Research and Development Command Science Symposium in Boston next Oct. 9-10.

Awards of $300, $200 and $100 will be given on the basis of the work described, contribution of the work to future performance of USAF's mission and the quality of the preparation and presentation of the papers. The center submitting the winning paper will receive a rotating plaque. Replicas will be given to individual winners.

The awards were initiated through the efforts of USAF Chief Scientist Dr. Guyford Stever, Gen. James Doolittle, and James Straubble of the Air Force Association. They will be presented by ARDC Commander Lt. Gen. Thomas S. Power.

Col. Stapp 'Grounded;' No More Sled Runs

Air Force Lt. Col. John P. Stapp, who rode a rocket sled at a speed of 632 mph during research into human factors, has been ordered to make no more high speed runs.

Brig. Gen. Marvin C. Demler, Deputy Commander for Research and Development of the Air Research and Development Command, said Col. Stapp still will be allowed to make routine track runs. Col. Stapp heads the center's Aeromedical Laboratory.

Gen. Demler said Col. Stapp "didn't like it one bit," but his superiors felt that Col. Stapp's "tremendous experience and know-how" make him too valuable to risk in more high-speed rides.

Col. Stapp set the ground speed record for humans in 1954 on a 2,000-lb. sled at Holloman Air Development Center, N. M. He reached a speed of 632 mph in 2,800 ft. and in five seconds' time. The sled decelerated with a force of 35 Gs and a wind pressure of more than two tons.

The Air Force said Col. Stapp's speed was equivalent to 1.7 times the speed of sound at 35,000 ft.

Gen. Demler said Col. Stapp "has really crowded the limit of human tolerance and has established several significant points on the curve of human tolerance. We don't believe he or anyone should stretch his luck any farther."

At Summer IAS Meeting:

Aerodynamic Heating Problems Reviewed

Los Angeles—Methods of dealing with aerodynamic heating and the advances in the state of VTOL/STOL aircraft art were the major subjects at last week's summer meeting of the Institute of the Aeronautical Sciences.

Departing from conventional programming, IAS also introduced a new topic to its agenda—sociological influences of aviation.

Approximately 1,000 engineers attended the four-day meeting which included closed sessions on supersonic propulsion and B-52 development.

AERODYNAMIC HEATING

Before the engineer can be confident in his design said E. R. Van Driest of North American Aviation's Missile Development Division, the following areas of research in aerodynamic heating must be further explored:

- **Surface roughness** and free-stream turbulence on the control of laminar to turbulent transition by cooling of supersonic flow for flat plates with cylindrical leading edges and for cones with spherical noses.
- **These same effects** for hypersonic flow with realistic temperature behind the bow wave.
- **Turbulent heat transfer** on flat plates.
- **Roughness effects** on turbulent heat transfer at ordinary supersonic flow.
- **Stability of boundary layers** near the stagnation point.
- **Viscous flow solution** at leading edges of plates and points of cones.
- **Heat transfer** in separation areas such as before control surfaces and in wakes.

Experiments show that cooling the boundary layer delays transition from laminar to turbulent flow. This delay not only decreases the aerodynamic heating rates considerably, according to Van Driest, but also increases the performance of winged high-speed vehicles.

Mach 3 Airliner

As an example of the effect of transition on performance, Van Driest cited a futuristic commercial airliner designed to fly 3,000 mi. at a speed of about Mach 3. It could very well have a zero-lift drag coefficient composed of 50% pressure drag and 50% turbulent friction drag.

If the boundary layer could be stabilized by cooling so that considerable laminar flow prevailed over the airplane surface, skin friction drag might be reduced by as much as 50%, which would reduce drag coefficient by 25%.

If other factors remain constant, the range would vary proportionally to the square root of the ratio of the drag coefficient with turbulent flow to that with laminar flow. In this case the range would increase about 15%, or about 450 mi.

Anti-Heat Methods

Methods for protecting or cooling surfaces and cooling internal compartments seem feasible for both steady and transient flight conditions, according to D. J. Masson and Carl Gazley, Jr., Rand Corp., aerodynamicists.

For the lower range of flight equilibrium temperatures or lower transient heat loads, use of a thickened metallic skin appears to be the most efficient means of countering surface aerodynamic heating. In this range they said cooling of internal equipment by ultimate dissipation of heat to atmospheric air seems most feasible.

For higher flight equilibrium temperatures and higher heat loads surface protection is best accomplished by insulation of the outer structure plus internal cooling, or by a transpiration (controlled gas or vapor flow through a porous skin) or mass transfer system. Cooling of internal equipment is best done by an expendable vaporizing coolant or by thermal capacity of the equipment and structure themselves.

These systems, still in relatively early stages of development, offer probably the highest efficiencies, Masson and Gazley said. The gaseous discharge from the surface reduces the incoming convective heating. The degree of reduction at supersonic and hypersonic speeds is still a matter of conjecture, but theoretical and experimental work at low speeds indicates that it may be appreciable.

Surface Coatings

Surface coating which sublimes or chemically dissociates was offered as less complicated than transpiration. Coating materials include gypsum, magnesium nitride, and graphite. Such coatings, they said, eliminate the complication of a porous skin, the weight penalty of plumbing, and the necessity of control, as associated with transpiration.

Of the expendable coolants, water is the best heat transfer fluid because its latent heat of vaporization and ability to absorb sensible heat are the highest of these fluids. However its advantage over other fluids (methyl and ethyl alcohols, petroleum fuels and acetone) may be lost when the entire cooling system operation is evaluated.

In short time flights, less apparatus might be required if a fluid already on board such as fuel, is used and the equipment is near the fuel system. For long flight times and for unpowered flight, such as that associated with ballistic and glide missiles, systems utilizing water would be superior, Masson and Gazley said.

Simulation Problems

Simulation of heating and of loads experienced by a hypersonic vehicle is a major problem for the structural test engineer declared Lewis H. Abraham, missile strength section chief, Douglas Aircraft Co.

Methods used to simulate aerodynamic heating include use of hot gases, electric blankets, radio frequency induction heating, resistance heating, solar radiation, hot hoop radiation and wind tunnel testing.

Best source, disregarding size of specimen it can handle, is only capable of producing heat flux of a vehicle traveling at a speed of Mach 8 or 9 at low altitude.

Above this range free flight testing appears to be a solution, using a high performance rocket to which the structural unit under test would be attached. Test vehicles could be multi-stage devices, Abraham said, with the final stage even programmed to fire vertically downward, achieving high Mach numbers at high dynamic pressures.

This type of testing is expensive, requires large operational ranges and large quantities of instrumentation, he said.

Structural and material advances will keep pace with advances in aerodynamic and propulsion, so that progress will not be slowed by the thermal barrier, according to Norris F. Dow, structures engineer, General Electric Co.'s Special Defense Projects Dept.

For moderate hypersonic speeds and flight durations conventional structural materials may be utilized as heat sinks, he pointed out, and the selection of the proper material to use still depends primarily upon structural characteristics rather than thermal conductivity.

To absorb a 3,000 btu. heat pulse for 30 sec. duration the approximate weight of 2024-T3 aluminum alloy would be 11.2 lb. per sq. ft., 17-7 PH stainless steel would be 10 lb. per sq. ft., and RC 130A titanium alloy would be 7.2 lb. per sq. ft.

On this basis, the use of titanium alloy as a heat sink would permit more poundage to remain for structural purposes.

IAS Meeting Coverage

Coverage of the summer meeting of the Institute of Aeronautical Science at Los Angeles last week was provided by a team of Aviation Week writers from the Los Angeles bureau that included Irving Stone, Richard Sweeney and Bernie Lang.

VTOL/STOL

The Army's VTOL/STOL vehicle was defined by Lt. Col. M. J. Strok as one capable of operating from unprepared terrain with VTOL/STOL characteristics without sacrificing normal medium speed advantages. While capable of VTOL, it should perform as an STOL in a 100% overloaded VTOL situation. Several areas worthy of intensive research and development efforts, in addition to normal aerodynamic and propulsion investigations, listed by Colonel Strok, are:

- **Reliability.** Powerplant failure should not endanger the entire aircraft's safety. Component design should be such that material or functional failure will permit the aircraft to make a safe landing.
- **Ease of operation.** No extensive or expensive training programs or radical changes in piloting techniques should be needed to take full advantage of the aircraft's capabilities. Human engineering techniques must insure a minimum number of control loops the pilot must close for various flight conditions.
- **Ease of maintenance.** A design goal must be 1,000 operational hours between major overhauls. Dirt, dust, temperature extremes and corrosion are to be considered normal. Load carrying and running parts and assemblies should be sealed if possible and have controlled atmospheres. Use of sealed design and/or unitized and integral package concepts to simplify replacements would be highly regarded.
- **Boundary layer control.** A low energy requirement type would achieve significant increases in maximum lift coefficients and forward speeds.
- **Propeller design.** High static thrust efficiency along with high speed efficiency is required.

Kenneth Coward, preliminary design engineer, Ryan Aeronautical Co., said his company's deflected slipstream type of VTOL falls into the conventional propeller category.

Ryan Philosophy

Tests on propeller static thrust, including investigation of the relationship between propeller thrust and angle of twist at certain power settings, indicates that propeller twist can be varied over wide limits. This permits translation of maximum engine power into static thrust at low twist angles without serious effect at high speeds.

Ryan also has introduced a "figure of merit" (ratio of ideal power output to the actual power output to generate a given static thrust) to facilitate computing static thrust, knowing propeller diameter, power input and air density.

Ryan mounted a full-scale test section on hydraulic mounts to measure all six components: lift, drag, pitch, roll and yaw moments and side force. The tests indicated at what angle to the ground the plane must be flown to achieve a slipstream 90 deg. to the ground and thereby effect vertical flight. The points plotted on a graph were actually slipstream angle with the complement representing the airplane's actual angle.

Under problems of hovering flight with deflected slipstream VTOL aircraft, Coward listed:

- **Powerplant failure.** When STOL conditions prevailed, powerplant failure assumed the same importance it has with conventional fixed wing airplanes. A certain critical area between vertical ascent and a forward speed capable of supporting flight might be safely overcome by interconnecting propellers in case of one engine failure, Coward said.
- **Control in hovering.** Solutions possible include locating control surfaces in the slipstream, use of exhaust gases from turboprop engines, separate small gas turbines located at the aircraft extremities or small rocket motors.

The transition system must not be so complicated that the pilot must reorient his control process. Any mechanical system to achieve transition must be extremely simple and positive.

Another control factor is tail size. A tail adequate in size for VTOL becomes a lift factor in normal flight and takes care of tail control at the 60% CC location which will be standard for VTOL aircraft.

Scott Rethorst of California Institute of Technology outlined a theory for analysis of a wing extending through a propeller slipstream. The new theory is based on lifting surface considerations and employs a method of analysis valid at all jet velocity ratios.

Magnitude and distribution of lift for any arbitrary combination of wing slipstream geometry and at all ratios of slipstream velocity to forward flight velocity are predicted. The results are in parametric form.

In developing this theory, Rethorst said, the method of analysis replaced the wing with a series of finite horseshoe vortices, and the case for each vortex inside and outside the circular jet stream was solved separately. The vortices were represented in width parametrically so that combinations could be superimposed to represent any arbitrary jet-wing combination.

Results of the analysis are values of downwash at all points in space due to the jet boundary. Inserting the downwash values into a suitable theory obtains final results expressed as magnitude and distribution of lift.

SAC JET TRANSITION

"Transition pains" began with the first delivery when the Strategic Air Command switch from propellers to turbines got under way in 1951, Col. Richard Evans of SAC headquarters told the IAS meeting.

As Col. Evans related, the base fire chief at McDill Field, Tampa, Fla., saw smoke trailing from the six jet engines of the first delivered B-47 medium bomber as the pilot, Col. Michael McCoy, was walking out to fly the aircraft. The exhausts of the brand new engines, as a result, were baptized with foamite.

Col. Evans described the many changes to which SAC crews had to adjust:

- **Three men** did the work formerly

Economist Forecasts Stable Industry

Stability in growth with earning power becoming more predictable is the outlook for the aircraft industry, George Steiner, senior economist for Lockheed Aircraft Corp., told IAS members. Other predictions from his paper, "An Economist Looks at Aviation":

- **Disarmament** is so unlikely that it can be eliminated as a factor in the aircraft industry outlook.
- **Shift** by international Communism from military strength to economic pressures will not permit the U. S. to lower defense spending. Of this continued high spending, the aircraft industry will get a major share.
- **Stability** which will result from this Red competition and from increased gross national product through 1970 will enable aircraft companies to keep skilled work forces intact and plan better for capital expenditures.
- **The military** will be more cost conscious since money it uses could be used for public works programs or returned to taxpayer as tax reduction. Fewer units will be produced for military, but units will be more efficient, more sophisticated and will have a much higher unit cost based on today's dollar.
- **Industry competition** for defense dollars will increase, with military spending going to keep force-in-being modern, to replace obsolete equipment and to keep technological advances flowing into U. S. arsenal.

done by 11, and the nature of the work was more involved.

• **Fuel consumption** made complete mission planning a must, so that once jet engines were started, there was no delay in reaching cruising altitude.

• **Temperature effects** on jet takeoffs were critical; accelerations progressed swiftly, and the time of decision on go or no-go for pilots became almost nothing. The decision had to be right.

• **Cruise control** of jets was imperative, and all factors weighed heavily outside air temperature, airplane gross weight, rate of gross weight change, cruising altitude and Mach number.

• **Pilot techniques** had to be adjusted to aeroelastic wings which flap at high Mach numbers and in turbulence.

Col. Evans related another experience of Col. McCoy, commander of the 306th Bomb Wing. Col. McCoy was riding in a B-47 nose compartment with two student pilots. The plane entered a thunderstorm, and the B-47 wings were flapping the full 17 ft. at each tip. The colonel growled into the intercom, "One of you guys climb outta there, I'm coming up." Where upon all three pilots met in the passageway.

• **Operations** near jet stream made frequent precise navigational position checks mandatory. Operating the B-47 included considerations of optimum altitude combined with pressure pattern and jet stream flight, making compromises and evaluations necessary by the pilot at frequent intervals.

• **Flight rules** and traffic control procedures had to be revamped to accomodate jets.

• **Limitations of Mach** number and altitudes introduced several new terms to pilot language. "coffin corner," where low speed stall and high speed stall or buffet are the same, was one. This condition applies for a specific altitude-temperature, and as a result, pilots must be constantly cognizant of their environment and gross weight. A second term was aileron reversal which covered the effects of aeroelasticity in control.

Application of aileron control in B-47s traveling at high Mach numbers resulted in aerodynamic pressures on the ship which combined with the elasticity of the structure to turn the wing into a super aileron. In effect, instead of being a primary control surface, the aileron acted as a servo tab for the wing and the wing became its own control surface.

Right aileron produced a roll to the left, as one pilot found out in a demonstration before a large civilian audience. He needed right aileron correction to take him past the reviewing stand at high speeds. He applied it, and when nothing happened he applied more and more. Suddenly the airplane rolled left and he streaked past the rear of the reviewing stand.

Rates of descent were critical, leading to a need for the best in terminal weather when deciding when letdowns should start. Fuel consumption at low altitudes dictated optimum letdown, and greatest assurance of completed landing once letdown started. Several adequate configurations of penetration have been developed, built around vor facilities.

Together with GCA (radar) monitored ILS approaches, one-minute interval landings have been effected in B-47 tactical units.

Control of the airplane on final approach, and estimates of landing completion and roll are critical with jets. Engine power requires time to build up for go-around, and the plane takes time to accelerate. Bad landing recoveries with engines are difficult, if not impossible, due to time lag between power application and effectiveness.

Better engines, like the J-57 in the B-52, combined with thrust reversers will end the more hazardous aspects of close-to-the ground operations, Col. Evans said, leaving the airlines to combat the one big problem in their transition to jets.

Noise has left its mark on SAC's neighbors. It is blamed for nervous disorders, social disgrace and an increasing birthrate.

SAC feels that if the airlines alleviate this problem, they'll have jets licked in a breeze.

Boom Is Forecast in Air Travel

Air travel trends indicate that two-thirds of the nation's common carrier travel will be by air in the 1970-75 era, Lloyd B. Aschenbeck, supervisor-market research Douglas Aircraft Co., Inc., told IAS members last week.

Aschenbeck also forecast that the demand for scheduled domestic seat-miles will exceed supply in 1965 by 14.5 to 24.5 billion seat-miles.

The basis for these projections involve an exploration of all factors that influence common carriage of people, Aschenbeck said, including the use of proper aircraft over the routes of an airline, the range of fares, extent of the competition and economics of a country. The Douglas economist's emphasized the basic economy of the region served by a carrier.

Present trends indicate, he said, that air travel is on the increase and may make it possible for common carrier travel, as an industry, to regain its competitive position for the consumer dollar.

Since travel may be tied to the economy of the nation, Aschenbeck

Three Records for the Hound

Russian Mi-4 "Green Grasshopper" helicopter designed by Mikhail Mil have had three new world records claimed for them. If homologated by the FAI, these will bring to five the number of official world records for helicopters held by the Russians. First mark set was an altitude of 19,472 ft. with two tons (metric tons, at 2,200 lb. each) payload. On the following day, an altitude of 19,842 ft. was reached with one metric ton of payload. Three days later, the Hound covered a triangular course of 310.7 mi. at an average speed of 116.3 mph., also claimed as a record.

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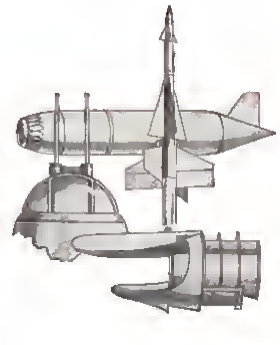

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used a national income forecast developed by the Congressional Joint Committee on the economic report which applies the travel factor (amount of travel purchased per $100 of national income) to establish the basic trend for traffic development. After establishing travel trends for surface and air, he projected the relative values of each mode of transportation.

Air Percentage

On this basis, he predicts air will account for nearly 50% of total common carrier travel in 1960 and 55% by 1965.

"Looking ahead to the 1970-75 era," he said, "it is possible to foresee that two thirds of all common carrier travel in the U. S. will be by air. The philosophy of more for your money is the basic appeal which combined with proper distribution means success in the marketing field."

To forecast demand for passenger miles in terms of supply, he arrived at a seat-mile forecast by applying a passenger load factor to the passenger-mile forecast.

"The upper limit is based on an average load factor of 55%, which should assure profitable operation and achieve the requirements of adequate scheduling and ability to handle peak loads, according to Aschenbeck. Today's reciprocating aircraft have an average breakeven load factor, for total costs, of slightly greater than 50%. However, by 1965 nearly two-thirds of all seat miles will be produced by turbine powered aircraft which have average breakeven load factors less than 50%.

In developing the seat-mile productivity of equipment operating in 1960 and 1965, Aschenbeck used the following assumptions:

- **Equipment now on order** will be delivered and operated by year end 1960.
- **Jet transports** on optional order will be delivered and operated prior to 1965.
- **Present reciprocating engine** aircraft will be gradually retired from the major trunk lines and will find a market in other types of service.
- **DC-6 type aircraft** will all be operating as coaches by 1950.

Taking these into consideration and using the forecast band, Aschenbeck said the U. S. demand for scheduled domestic seat-miles will exceed supply in 1965 by 1.45 to 2.45 billion seat miles.

The method also establishes a control curve within which the forecast of regional traffic must operate, he explained.

Large shifts in population in the U. S. as well as the increase in population and the new industries have a "tremendous effect" on the changing economics of a given marketing area. Civil Aeronautics Administration has grouped the cities served by the airlines into four classes: marketing, institutional, balanced and industrial.

Buying Index

By use of several economic indicators, a symptomatic index of the buying potential of a city can be assigned," Aschenbeck said, taking into consideration such elements as population, retail sales and disposable income.

He made it clear that air travel is sensitive to disposable income and therefore a symptomatic index should contain disposable income to reflect the ability of a regional economy to generate air travel.

It may appear, he said, that cities of equal buying power ability should generate equal amounts of air travel. This is not always true. For instance, he explained, a city which is classified according to the CAA type as industrial will not, as a rule, generate as many passenger-miles as a city classified as marketing or institutional, even though the industrial city has equal buying power for consumer goods as measured by the buying power index.

He outlined airline considerations for equipment needs, taking into account route structure, scheduling competition, types of service and fares and airplane performance and economics.

All these factors, Aschenbeck said, add up to giving an airline a guide as to the number and type of aircraft needed in its expanding business.

News Digest

Chance Vought is developing an air-to-ground version of the Navy's Regulus sea to sea missile which it hopes to sell to the USAF.

McDonnell Aircraft Corp. has $52,630,000 in new business from USAF and Navy. Included are prime contract for one new missile and major subcontract for another. Total new missile contracts are $25 million, to bring missile backlog to $36 million. Overall backlog is $668 million.

Longest Firebee flight of 105 mi. from remote control ground station—has been made after air launch from JD-1 at the Naval Air Missile Test Center, Point Mugu, Calif. Ryan jet target drone then was turned around and retraced over water route for total run of 210 mi. Automatic parachute lowered Firebee into ocean just offshore and pickup was made by Navy.

First F-100D produced at North American Aviation, Columbus, Ohio plant test flown.

F.A.I. Confirmed world speed record of 1,132 mph. set by Peter Twiss in Fairey Delta 2.

CAA Certification of RCA AVQ-10 C-band weather radar system is the first for commercial airborne radar equipment. American, Continental, Pan American, Trans World, United, Air India, BOAC, Cia. Mexicana de Aviacion, Iberia, Sabena, Swissair and Union Aeromaritime de Transport have purchased the equipment.

Net sales and other income of Ryan Aeronautical Co., for first half of Fiscal 1956 total $21,909,142, according to an unaudited statement. Increase over same period last year is 12%. Net profit after provision for federal income tax was $683,492, equal to $1.80 a common share, down from $796,596 and $2.09 last year.

Flight test facility for Radioplane Co., projects has been established at Holloman Air Force Base by Northrop Aircraft, Inc.

Aviation agreement signed by Dr. Heinrich von Brentano, West German foreign minister, and Thomas Kiernan, Irish minister at Bonn, will permit Aer Lingus to fly between Dublin and West Germany and operate on a route from southern Ireland to Italy via southern Germany and Switzerland. In return, Lufthansa will fly to Dublin and can use Shannon Airport as a transatlantic stop.

Me 200 built in Spain was inspected at Duesseldorf Airport by West German aviation experts. Trainer is powered by two Marbore II jet engines mounted in nose.

General Electric set up a new Defense Electronics Division, one of three new groups formed out of the previous Electronics Division. George L. Haller has been named manager of defense electronics. The other two new divisions are industrial electronics and electronic components. The latter will include CE's tube, semiconductor and specialty component departments.

Coordination of B-47 modification and overhaul will be handled by B-47 modification IRAN group, Oklahoma City Air Materiel area.

Major missile and aircraft control problems are being subcontracted by Republic Aviation to Systems Laboratories Corp., Los Angeles. Dr. John L. Barnes heads firm whose formation was announced only last week.

Fourth airline to order the Frye Corp. F-1 Safari is Samoan Airlines, Ltd. Contract calls for two 51 passenger models to be delivered in mid 1958.

Charter Ticket Sales Boom on Atlantic

Carriers expect 90,000 passengers will cross to Europe this summer in chartered aircraft.

By Glenn Garrison

New York—An estimated 90,000 passengers will cross the North Atlantic in chartered aircraft this summer. Scheduled airlines, together with contract carriers, will haul about 23% as many people in charters—civilian groups and military dependents—as the scheduled lines will carry on their regular flights.

Flying Tiger Line alone, pushing its commercial charter business under a liberalized Civil Aeronautics Board policy, expects to handle 24,000 passengers June through September. FTL thus will handle more transatlantic charter passengers than all the scheduled airlines. Military contract will supply about 8,000 of the Flying Tigers' total.

Taking full advantage of the May 1955, CAB decision, Flying Tiger has set up an international charter division in New York under the direction of Brian Havhoe, former head of British Overseas Airways Corporation charter operations in New York. Operational facilities have been expanded to handle the expected business and additional equipment has been earmarked for the North Atlantic run.

Super Connie Order

This summer, Flying Tiger is operating seven DC-4s over the North Atlantic in its commercial charter work. Military contract flights are handled by a DC-6 which makes about 12 round trips a month throughout the year. Ten Super Constellations now on order will be delivered to FTL beginning next January, and five or six of these aircraft will be used for transatlantic charters.

The airline's overseas maintenance facilities have been shifted from Newark Airport to temporary quarters at Idlewild, thus eliminating a ferrying problem. Flying Tiger soon will move into part of National Airline's hangar at Idlewild, and expects to find ticket counter space in the airport's jam-packed passenger terminal by August. Ticketing now is handled at a New York hotel.

Abroad, FTL's maintenance base at Frankfurt, Germany has been expanded to handle the increased traffic.

Groups that have signed with Flying Tiger this year are as diverse as the Harvard Glee Club, the National Lutheran Council, the Clan MacKenzie and the Italian Alliance of Connecticut. (CAB requires that the travelers be members of a bonafide organization in whose name the charter is booked.) A broad potential market for group charters is seen by Havhoe.

A particularly fertile source of charter business, Havhoe said, are the recreational associations of large industries. Continuing charter business on a good size scale also comes to Flying Tiger, as well as to other carriers, from the Intergovernmental Committee for European Migration. FTL claims to lead in transport to the United States of these European refugees, has 25 ICEM flights scheduled for July alone.

Charter Volume

For the contract and scheduled carriers alike, the ICEM movements are a big help in filling charter aircraft on return flights to the U.S.

Of the other contract carriers, Slick Airways so far has gone in most heavily for commercial charter business. Slick, too, has a new charter division and is using two DC-4s in commercial charter service this summer. The airline also handles refugee charters, as well as a volume of military contracts that approaches FTL's.

This summer, Slick expects its transatlantic charter passengers will number about 11,000, of which 5,000 will be commercial. But the airline plans no real drive for commercial charters until next summer when, equipment permitting, it will step up its efforts in what it believes is a sizeable market.

Seaboard and Western's passenger charters this summer will almost all derive from the military. No 1956 estimate is available from Seaboard & Western, but last summer the carrier handled 28,000 military contract passengers.

Another 6,000 charter passengers, 80% of them military dependents, will be handled by Trans Caribbean Airways, that carrier estimates.

The charter situation with the scheduled transatlantic carriers is somewhat scrambled. Most of them would like plenty of charters in the off season, when there are empty seats around. But people want airplanes in the on season, when travel is the heaviest.

Nevertheless, almost half of the 40,000 transatlantic charter passengers carried by International Air Transport Association airlines in 1955 were accommodated somehow during four busy months, June through September.

Pan American World Airways and KLM Royal Dutch Airlines carry most of the IATA charter business. Last year, Pan American handled about 19,000 of the passengers KLM flew about 11,000. (Figures supplied by the airlines.) Half of the Pan American charters and about 10% of KLM's were military contracts.

Trans World Airlines handled about 4,500 charter passengers in 1955, about half of them military.

Summer Traffic

Most of the IATA carriers handle little or no charter work during the summer months. KLM, on the other hand, carries most of its charter traffic during the summer, and summer is a heavy charter season for PanAm, too.

KLM assigns a DC-4 to charter service on a year-round basis, adds a DC-6 from freight operation in the summer and uses other equipment when available.

Pan American, with enough crews and equipment to schedule extra flying during the season, divides the surplus between extra sections and charters as occasion demands. Extra sections where possible are chartered for return trip.

A method used at least occasionally in the charter business to find an airplane is to cancel a lightly-booked scheduled flight. This is a handy way of bringing up the load factor of a flight going in the wrong economic direction during the seasonal imbalance. And, as it takes place months ahead of flight time, perhaps the scheduled passengers do not mind.

The large scale entry of Flying Tiger and other contract carriers into the transatlantic commercial charter market doesn't worry the scheduled carriers who foresee plenty of this type of business for all, at least in summer. In the off season, when charter customers are scarcer, some competition is expected.

Although restricted to special groups by CAB in the case of the contract carriers and by IATA in the case of the scheduled carriers, the great demand for charter flights may well be another indication of the vast numbers of people who want to fly the Atlantic if the price is right.

How would a much lower IATA tourist fare affect the charter market? PanAm believes it would slow the demand. KLM feels it would eliminate it.

But Havhoe feels that Flying Tiger will be able to keep plancload fares far enough below tourist fares to continue to attract a sizeable market.

Hiller Vertical Riser

One of several vertical rising projects being developed for Army under auspices of Office of Naval Research is the Hiller 1048. Model is turbine powered. Tail section will have either auxiliary gas turbine or will utilize bleed-air from engines shown to provide pitch and yaw control. Wing pivots up and back for landing and takeoff, and is placed in a conventional position for horizontal flight.

Convair Will Build Golden Arrow

A $200 million plan to build a medium range, turbojet transport for Trans World Airlines and Delta Air Lines was announced simultaneously last week by two airlines, Convair Division of General Dynamics Corp. and the General Electric Co.

The new transport, to be called the Golden Arrow, will be built as a combined project of Convair, General Electric, Delta and the Hughes Tool Co., which controls TWA. The total amount of the airlines order for 40 Golden Arrows, including spares, is "well in excess of $200 million."

Official announcement of the four-way deal to put the transport into production substantiates an AVIATION WEEK report of TWA's order for 30 and Delta's order for 10 Skylarks from Convair (AW, June 18, p. 40). The Golden Arrow is the latest version of the Convair Skylark 600 proposal.

Plans to use gold-colored metal for the exterior of the Golden Arrow will make the new transport stand out from conventionally colored transports. The airplane will be the first, according to its backers, to include exterior metal of gold "rather than the conventional silver color associated with airplanes through the years."

Delivery of the Golden Arrow to both TWA and Delta is scheduled to begin in late 1959. It will have a top cruising speed of 609 mph. and will be powered by four General Electric CJ-805 (J79) turbojet engines.

The Golden Arrow is designed to operate efficiently and economically at ranges from 200 to 3,000 miles, and it will operate in and out of 5,000 ft. runways.

The companies said the 5,000 ft. runway is the common maximum at many airports and is too short for "any other commercial jet airliners announced up to this time."

Tower-Handling of Low-Altitude IFR Flights Reduces Delay

Speedier handling of short-distance Instrument Flight Rules traffic and some relief for overworked en route traffic controllers have resulted from a Civil Aeronautics Administration program started several years back and now operative at some towers throughout the country.

No panacea for the controllers' problems, area control of low altitude traffic by towers instead of by CAA control centers has at least served as a finger in one section of the traffic control dike. It has greatly reduced IFR departure delays at many airports and cut sharply into the workload of the en route centers.

The program makes it possible for centers to turn over responsibility for all IFR traffic at certain altitudes, usually under 5,000 ft. to the local approach control towers involved.

The towers clear departing aircraft directly, instead of calling the center, waiting their turn, and then receiving the clearance to pass on to the flight.

Departures are coordinated with approach towers at destination airports, and en route control of these flights—usually of 100 miles or less—remains with the towers all the way.

The program originated several years ago in CAA's region one and has gradually expanded through that area and adjacent regions. The service also is used to a lesser extent at various other cities in the country.

Typical of locations where tower control has reduced departure delays from 20 minutes or more to less than five minutes is the upper New York State area including such points as Elmira, Binghamton, Ithaca, Rochester, Buffalo and Syracuse. In cooperation with the Canadian Department of Transport, the service also has been instituted between Buffalo and Toronto, and between Burlington, Vt. and Montreal.

Local service carrier operations and the shorter-haul operations of trunklines have been greatly aided by the service. Examples:

- **Eastern Air Lines** departure delays have been reduced over such segments as Baltimore-Washington-Philadelphia and Richmond-Charlotte-Raleigh-Durham. Some 35-40% of Eastern's flights are in the short-hop category, according to Capt. John Gill, eastern region chief pilot, who says of low altitude control "I don't know what we'd do without it."
- **American Airlines** has found the service especially valuable between such points as Nashville-Louisville-Cincinnati-Dayton. Departure delays between Cincinnati and Dayton formerly averaged 10-15 minutes. Today, there are "practically no delays," according to David Little, chief of American's airway aids and electronics section.
- **Mohawk Airlines** clearance delays have been cut by 85 to 90% through local control. Carl A. Benscoter, Mohawk vice president-operations,

would like to see the service extended even further

CAA's Region 1 estimates the reduction in en route control center workload at 10 to 20% through use of low altitude control.

The first actual use of the tower area control principle occurred in 1949, when CAA authorized Norfolk and Richmond, Va. towers to control IFR traffic at certain altitudes without coordination through the Washington center.

Other points including Washington and Baltimore, started the procedure on a spot basis. In 1953, the first region developed an overall program which included standardized training for tower personnel taking over the area control duties.

CAA foresees expansion of the local control network to permit centers to concentrate on long distance express traffic. More efficient control of the higher altitude traffic following primary routes may permit extension of the length of flight segments handled by each en route express center.

Air France Starts Jet Freight

The first commercial jet operation since the end of Comet service began last week as Air France put a SNCASE SE 210 Caravelle into cargo service between Paris and Algiers. The almost daily flights, which include a stop at Marseilles on the outbound run from Paris, are designed to build experience toward passenger operation of the twin-jet aircraft late in 1958.

Crews from the French flight test center at Bretigny will operate the Caravelle over the route daily except when special tests interrupt the cargo service.

A second pre-production Caravelle will be added to the run sometime next winter.

The experimental operation will provide mechanical experience with the Caravelle and also train crews, ground handling and operations personnel in day-to-day use of the aircraft. Air France has ordered twelve Caravelles and optioned 12 more.

The initial cargo flight made the 400-mi. Paris-to-Marseilles leg in an hour, covered the remaining 477 mi. to Algiers in 81 minutes. Production Caravelles will cruise at about 470 mph., carry up to 90 passengers on routes up to 1,700 mi.

The aircraft's two 11,000-lb.-thrust Rolls-Royce Avon turbojets are located well aft on the fuselage just ahead of the tail.

This novel configuration is said to offer advantages of fire safety, low cabin noise level, and one-engine-out stability.

Payload of the Caravelle is 16,000 lb. for a range of 1,500 mi. with fuel reserve of 7,000 lb.

A later model of the Caravelle may be equipped with the Rolls-Royce Conway engine with a thrust in excess of 15,000 lb.

The Rolls-Royce model will be capable of carrying the same payload an additional 1,000 mi., or will be able to tote an additional 10,000 to 15,000 lb. of payload over the 1,500 mi. or shorter range.

George Hereil, SNCASE president, says his company could deliver production airplanes next year if the Avon engines were available. As it is Air France will not receive its production aircraft until early 1958.

Airliner Caught Fire While Dumping Fuel

A Lockheed Super Constellation of Linea Aeropostal Venezolana caught fire when the pilot attempted to dump fuel and crashed last week off the New Jersey coast. Sixty-four passengers and ten crew members were killed.

The pilot was attempting to return to N. Y. International Airport at Idlewild after having difficulty with an "overspeeding propeller" on No. 2 engine which he was unable to feather.

After being picked up by a Coast Guard air rescue Grumman Albatross, the LAV pilot started to dump fuel to lighten the aircraft about 25 min. prior to his expected landing at Idlewild. A minute later, according to Lt. Cmdr. F. J. Hancox, pilot of the Coast Guard plane, he saw a "flicker of flame" on the right wing near the No. 3 engine. About two minutes later, the airplane, completely afire, crashed into the ocean.

The airliner, bound non-stop for Caracas, departed from Idlewild at 11:16 pm. and was about 250 mi. east of Norfolk when the pilot turned back.

LAV's Super Constellation was equipped with Wright R3350-DA1 turbo-compound engines. It had Hamilton Standard 43H60 propellers on No. 1, 2 and 3 engines and a 43E60 propeller on No. 4, according to Lawrence Penn, LAV's chief mechanic in New York.

India Bargains with USSR For Fleet of Ilyushins

New Delhi—India is negotiating for a fleet of Ilyushin Il-14 airliners to replace Indian Airlines' over-age DC-3s. A firm order will be placed with the Russian manufacturers if price is right.

Two Russian experts have given technical details to Shankar Prasad, chairman of the Indian Airlines Corp. and officials. They assured New Delhi that spare parts and maintenance tools would be available for servicing the planes in India.

Indian Airlines personnel who have flown the prime minister's Ilyushin "Meghdoot" say the Russian aircraft compares favorably with the DC-3 in speed and climb. Furthermore the aircraft can take off and land on plain ground. Another pointer in favor of the Indo-Russian deal is the aircraft's easy availability.

Seaboard & Western Reports Revenue Gain

Washington—Seaboard and Western Airlines last week reported a 28% increase in gross revenues for the first quarter of 1955 over the same period of last year. Net income for the first three months amounted to $5,700 as compared with a net loss of $126,800 in 1954.

Commercial air freight traffic during the period totaled 3,726,000 ton-miles compared with 2,147,000 ton-miles for the 1954 quarter.

CAA Reports Increase In Pilot Registration

Washington—A substantial increase in the number of new pilots has been reported by the Civil Aeronautics Administration.

The number of airline transport licenses issued in 1955 climbed to 860 from a total of 627 in 1954. Private pilot licenses climbed from 15,523 in 1954 to 16,632 in 1955.

Among non-pilots licensed by the CAA, the number of new mechanics increased from 3,867 in 1954 to 4,435. In other categories, the number of parachute riggers and flight navigators licensed dropped almost 50%. Licenses to flight engineers increased, but the number of new air traffic control tower operators decreased.

National Safety Council Honors 40 Local Lines

Washington—Forty domestic trunk, territorial and local-service airlines have received the National Safety Council Award of Honor for operating through out 1955 without a passenger or crew fatality.

Total passenger fatality rate for the entire scheduled domestic industry in 1955 came to 76 deaths per 100 million passenger-miles.

During the year, there were seven fatal accidents with a loss of 156 passengers and 21 crew members.

"Floating Cabin" Proposed for 707

Peterboro, N. J.—Boeing is studying the possibility of floating the entire passenger compartment of its 707 commercial airliner on approximately 1,000 shock mounts basically similar to those used to protect delicate electronic equipment in jet aircraft and missiles. Boeing engineers probably will build a mockup of a portion of the cabin to evaluate the idea.

The plan is to suspend only the floor and a section running up the sides approximately 14 in. The mounts would be of the Met-L-Flex type using resilient cushions of knitted wire, designed and made by Robinson Aviation, Inc., Teterboro, N. J.

Robinson engineers say that large jet aircraft experiences two types of vibration that could cause passenger discomfort on long flights: a 25-cps. frequency caused by the air turbulence and excitation from the jet engines running as high as 500 cps.

Piedmont Airlines Orders 12 Friendships

Piedmont Airlines last week placed an $8 million order for 12 Fairchild F-27s and took an option on another 12 of the new turboprop transports.

The Piedmont order for the twin-engine aircraft powered by Rolls-Royce Darts is the largest yet announced.

Fairchild Engine and Airplane Corp. plans to fly its first F-27 in October 1957 and Piedmont is scheduled to receive its first airplane two months later. The initial order of 12 transports will be delivered by May, 1958.

The dozen F-27s purchased by Piedmont bring Fairchild's list of announced Friendship orders to 23 aircraft. Mackey Airlines has placed a firm order for two; West Coast Airlines has ordered four; Frontier Airlines, two; and Bonanza Air Lines, three.

Fairchild also is understood to have orders for several more F-27s awaiting announcement.

Piedmont President T. H. Davis termed the F-27, which the carrier will call the Pacemaker, ideal for his airline's operations. Davis said that a major factor in choosing the turboprop airplane was the fact that it will operate out of all airports on Piedmont's system without runway changes.

Davis said introduction of the F-27 will give Piedmont the opportunity it needs to get off subsidy, since it has a breakeven load factor of about 57%, while the breakeven point of the DC-3 is a practically unattainable 73%.

U.S., Foreign Transport Orders Total 1,175 in Re-Equipment Rush

American and foreign flag airlines have ordered 1,175 piston and turbine powered transports for delivery in the next five years.

The Air Transport Assn. reported last week that, as of June 1, U. S. flag airlines had ordered a total of 665 aircraft, foreign flag carriers, 510.

The largest number of orders has been placed for four-engine piston transports, including the Douglas DC-6A, DC-6B, DC-7, DC-7B and DC-7C, the Lockheed 1049G and 1049H Super Constellations and the Lockheed 1649. American carriers have ordered 281 of these transports, foreign carriers 144.

Orders for 367 long-range turbine powered transports have been placed 275 of them by U. S. airlines and 92 by foreign airlines. This group includes the Lockheed Electra, Bristol Britannia, Douglas DC-8 and Boeing 707.

In the medium-range turbine transport group American carriers have ordered 74 aircraft and foreign carriers have ordered 195 aircraft. In this category ATA lists the Vickers Viscount Vicker Vanguard, Fokker Friendship de Havilland Comet IV and SNCASE Caravelle.

The airlines have ordered 114 medium-range piston transports such as the Convair 440, Frve F-1 Safari, and Handley Page Herald. Of the total, U. S. flag airlines ordered 35 and foreign flag airlines ordered 79. Following is the ATA breakdown of the orders:

FOUR-ENGINED PISTON

Airline	Type	Total
American Airlines	DC-6A	4
American Airlines	DC-6B	8
American Airlines	DC-7	14
Braniff	DC-7C	7
California Eastern	1049G	2
Continental	DC-7B	5
Delta C & S	DC-7	10
Eastern	DC-7B	28
Eastern	1049G	10
Flying Tiger Line	1049C	10
National	DC-7	8
North American	DC-6B	8
Northeast	DC-6B	10
Northwest	DC-6B	17
Northwest	DC-7C	6
PAA	DC-7B & C	33
Seaboard & Western	1649H	5
Slick Airways	DC-6A	6
TWA	1049C	8
TWA	1649	25
United	DC-6A	5
United	DC-6B	21
United	DC-7C	17
U. S. Overseas	1049H	2
Western	DC-6B	16
Total U. S. Flag		281
Aerovias Brasil	DC-7C	2
Air France	1049G	8
Air France	1649	12
Air India	1049G	3
Airwork	DC-6B	2
Alitalia	DC-6B	2
Alitalia	DC-7C	3
Arsovia	DC-6A	1
ANA (Australia)	DC-6B	2
BOAC	DC-7C	10
CMA (Mexico)	DC-7C	4
CPAL (Canada)	DC-6B	3
Cubana	1049G	2
Lufthansa	1049G	4
Iberia	1049G	2
Japan Air Lines	DC-7C	4
KLM	DC-7C	10
KLM	1049G	4
LAI (Italy)	DC-6B	2
LAI (Italy)	1649	4
LAV (Venezuela)	1049G	1
Lufthansa	1649	4
Panair do Brasil	DC-7C	4
Qantas	1049H	2
Real (Brazil)	DC-7C	3
Sabena	DC-7C	3
SAS	DC-7C	14
South African Airways	DC-7C	3
Swissair	DC-7C	4
TAI (France)	DC-7C	2
TAP (Portugal)	1049G	2
Trans Canada	1049G	2
Thai Airways	1049G	2
Total Foreign Flag		144
Grand Total		426

MEDIUM-RANGE PISTON

Airline	Type	Total
Braniff	Convair 440	6
Delta	Convair 440	5
Eastern	Convair 440	12
National Air Lines	Convair 440	6
Northern Consolidated	Frye F-1	3
Wien Alaska	Frye F-1	3
Total U. S. Flag		35
Aero Oy (Finnish)	Convair 440	1
Air Cruise	Herald	8
Australian National	Herald	20
Iberia	Convair 440	5
Lloyd Aero Colombiano	Herald	6
Queensland Airlines	Herald	3
Real (Brazil)	Convair 440	4
Sabena	Convair 440	12
SAS	Convair 440	11
Swissair	Convair 440	11
Total Foreign Flag		73
Grand Total		114

LONG-RANGE TURBINE

Airline	Type	Total
American	Electra	35
American	Boeing 707	10
Braniff	707-320	5
Braniff	Electra	6
Continental	Boeing 707	4
Delta	DC-8	8
Eastern Air Lines	Electra	40
Eastern Air Lines	DC-8	20
National	Electra	23
National	DC-8	6
Pan American	Boeing 707	11
Pan American	707-320	12
Pan American	DC-8	25
TWA	Boeing	8
United	DC-8	30
Western	Electra	6
Total U. S. Flag		275
Air France	707-320	10
BOAC	Britannia	33
CPAL	Britannia	5
El Al	Britannia	3
Japan Air Lines	DC-8	4
KLM	Electra	13
KLM	DC-8	8
Lufthansa	Boeing 707	4
Swissair	DC-8	2
SAS	DC-8	7
Sabena	707-320	3
Trans Canada	DC-8	4
Total Foreign Flag		92
Grand Total		367

MEDIUM-RANGE TURBINE

Airline	Type	Total
Bonanza	Fokker	3
Capital	Viscount	83

Continental	Viscount	12
Frontier	Fokker	2
West Coast	Fokker	4
Total U. S. Flag		74
Aer Lingus	Fokker	4
Air France	Caravelle	12
BEA	Vanguard	23
BEA	Viscount	30
BOAC	Viscount	12
BOAC	Comet IV	20
British West Indian	Viscount	4
Central Airlines	Viscount	3
Cubana	Viscount	3
LAI	Viscount	5
Hong Kong Airways	Viscount	2
Hunting Clan	Viscount	2
Iranian Airways	Viscount	3
Indian Airlines	Viscount	5
Iraqi Airways	Viscount	4
KLM	Viscount	9
KLM	Fokker	2
Alaskey	Fokker	2
New Zealand National	Viscount	3
Lufthansa	Viscount	9
Oasis (Norway)	Viscount	2
Pluna (Uruguay)	Viscount	2
Transair (U. K.)	Viscount	2
Trans Australia	Fokker	6
Trans-Canada	Viscount	10
Philippine Airlines	Viscount	2
Burma Airways	Viscount	3
Total Foreign Flag		105
Grand Total		200

American to Switch Detroit Terminal

Detroit—American Airlines will move its Detroit terminal from Willow Run to the Wayne Major Airport late in 1958. The airline has commissioned Giffels and Vallet, Detroit architects to design and construct a $2.5 million hangar and air cargo building at Wayne Major and the airport itself has engaged the same firm to draw plans for a first stage air terminal building.

American expects a drop in revenue, perhaps as high as 10 or 20%, because of the transfer. Wayne Major, situated 13 miles nearer Detroit than Willow Run, will attract more customers in time, the airline believes. No other scheduled airline operating out of Willow Run is planning to move. They are waiting to see how American gets along.

Wayne lacks the facilities and runways of a major airline terminal and as much as $19 million will be needed to make it acceptable. Wayne officials admit. The cost of the proposed terminal building would be $3 million. Wayne Major has been granted $1 million federal aid, which must be matched locally. What money is received will be spent on runways, taxi strips, buildings and loading platforms.

Pan American Leases New York Terminal Site

New York—Pan American World Airways has leased a 17-acre site from the Port of New York Authority to construct a passenger facility in the "terminal city" at New York International Airport. Eastern Air Lines, United Air Lines and American Airlines previously have leased terminal sites in the 655 acre area.

First Airworthiness Regulations For Helicopters Adopted by CAB

Washington—The Civil Aeronautics Board has adopted a set of helicopter airworthiness regulations that will give manufacturers their first definite, comprehensive rule book for guidance in the certification of rotary-wing aircraft.

The new Part 7 of the Civil Air Regulations separates helicopters into three classes, including two categories which cover the use of the aircraft as commercial transports. The rules become effective on August 1.

Under the new pattern, small helicopters fall in the normal category for rotorcraft of 6,000 lb. or less maximum weight. This type of aircraft remains under CAR Part 6, which has been modified to simplify and clarify requirements for certification of small helicopters.

The new CAR Part 7 separates transport helicopters into two categories. Transport Category A covers multi-engine aircraft of unlimited weight. Transport Category B, single or multi-engine aircraft weighing between 6,000 and 20,000 lb.

CAB Requirements

Helicopter manufacturers and operators have been working with the CAB for several years in an attempt to develop a definite set of airworthiness standards for rotary wing aircraft. Until the new CARs were adopted, all helicopters were lumped together under Part 6.

Last year, the CAB issued a draft proposal for the new pattern of airworthiness regulations. The industry submitted its comments to the Board, and the Board made some changes, principally in performance rules, before the rules were issued in their final form.

When it adopted the new CARs the CAB said it had considered the problem of whether specific airworthiness requirements for large rotorcraft should be issued before significant operating experience was available. The Board said it then decided to go ahead and issue broad objective standards in the belief that "safe operations are most assured where basic standards have been established."

When the CAB helicopter proposals were issued in 1955, operators objected to establishment of performance rules because of the lack of operational experience with the larger helicopter types included in the new transport categories.

Recognizing this objection, the CAB limited its quantitative performance regulations to two requirements. Category A helicopters must have a 100 feet per minute rate of climb with one engine out, and Category B helicopters must have a minimum hovering ceiling of 4,000 ft.

Performance Limits

The Board said that performance operating limitations will be developed and included in the CARs as quickly as the state of the art permits. In the interim, the Civil Aeronautics Administration will be responsible for limiting air carrier operations and other operations over congested areas to insure a safe operation.

In the original proposal, the upper weight limit for Category B was 17,500 lb. The CAB raised this to 20,000 lb. when some manufacturers told the Board that design studies for single engine helicopters weighing more than 17,500 lb. were under way.

Helicopters present special fire protection problems because their power plants are not as isolated as engines on fixed wing aircraft, and the CAB said it gave particular consideration to the problem.

Fire-Protection Rules

Fire-protection requirements for Category A helicopters are designed to permit a fire to be extinguished and the flight continued to a suitable airport. Requirements for Category B helicopters are intended to protect the helicopter and its occupants during an immediate descent and landing.

Requirements that helicopters be designed for a positive maneuvering load factor of 3.5 and a negative load factor of 1.0 are considered high by the industry. The Board said it didn't change these load factors, which are the same as those specified in Part 6, because of a lack of substantiation of other values.

But the CAB also said that, since some comments questioned the necessity for such high values for transport helicopters, the issue is being made a matter for further study.

CAB ORDERS

(June 7 13)

GRANTED:

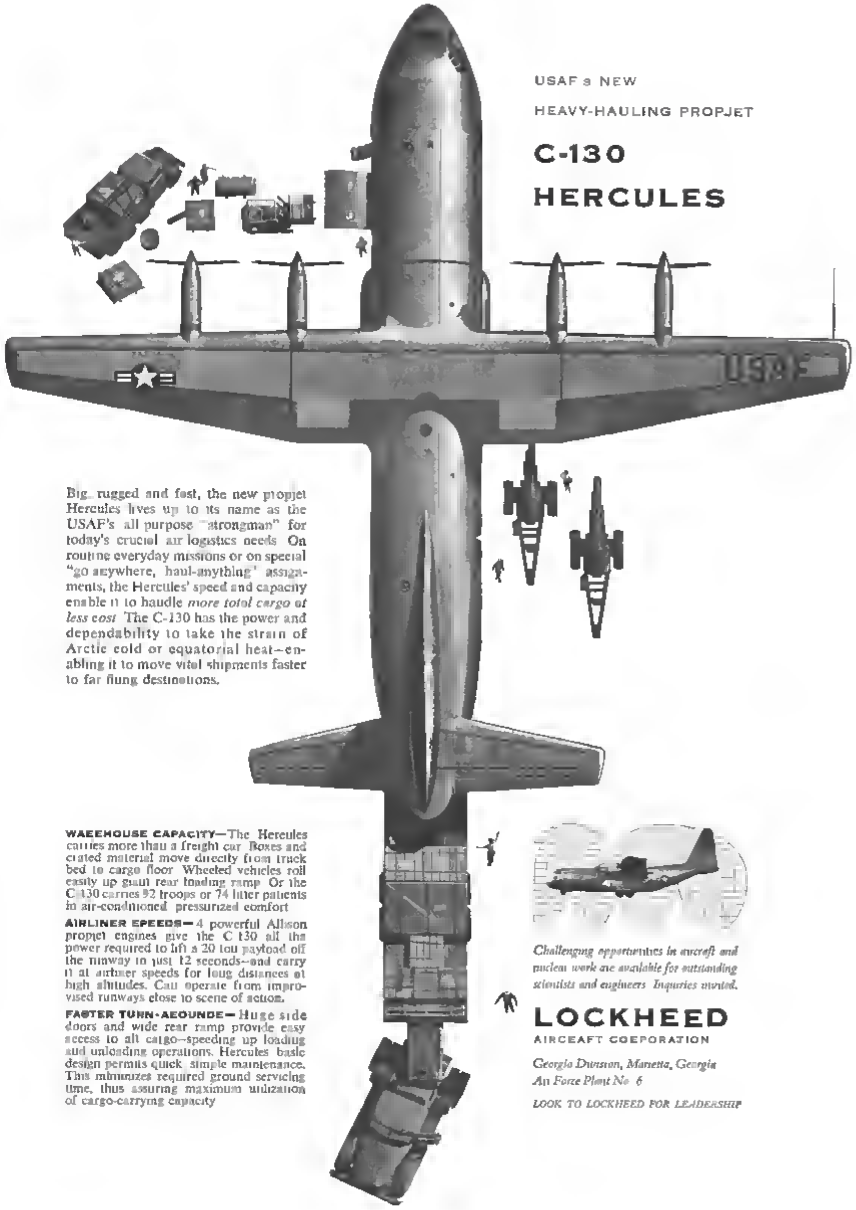
West Coast Airlines an exemption to operate one roundtrip flight a day between Seattle and Ephrata-Moses Lake, Wash., via Wenatchee on a turnaround basis.

Flying Tiger Line an exemption to operate a charter flight from New York to Paris pursuant to a contract with the National 4H Club Foundation.

Frontier Airlines authority to overfly Cortez, Colo., and Gallup, N. M., on all flights

USAF's NEW
HEAVY-HAULING PROPJET

C-130
HERCULES



Big, rugged and fast, the new propjet Hercules lives up to its name as the USAF's all purpose "strongman" for today's crucial air logistics needs. On routine everyday missions or on special "go anywhere, haul-anything" assignments, the Hercules' speed and capacity enable it to handle *more total cargo at less cost*. The C-130 has the power and dependability to take the strain of Arctic cold or equatorial heat—enabling it to move vital shipments faster to far flung destinations.

WAREHOUSE CAPACITY—The Hercules carries more than a freight car. Boxes and crated material move directly from truck bed to cargo floor. Wheeled vehicles roll easily up giant rear loading ramp. Or the C-130 carries 92 troops or 74 litter patients in air-conditioned, pressurized comfort.

AIRLINER SPEEDS—4 powerful Allison propjet engines give the C-130 all the power required to lift a 20 ton payload off the runway in just 12 seconds—and carry it at airliner speeds for long distances at high altitudes. Can operate from improvised runways close to scene of action.

FASTER TURN-AROUND—Huge side doors and wide rear ramp provide easy access to all cargo—speeding up loading and unloading operations. Hercules basic design permits quick, simple maintenance. This minimizes required ground servicing time, thus assuring maximum utilization of cargo-carrying capacity.

Challenging opportunities in aircraft and nucleon work are available for outstanding scientists and engineers. Inquiries invited.

LOCKHEED
AIRCRAFT CORPORATION
Georgia Division, Marietta, Georgia
An Air Force Plant No. 6

LOOK TO LOCKHEED FOR LEADERSHIP

in excess of its present service at the points.

West Coast Airlines an exemption to overfly Eugene and Albany-Corvallis on one daily round-trip flight between North Bend-Coos Bay and Portland, Ore., on segments of Route 77.

APPROVED

Interlocking relationships between Paul Perrett, Rudolph Deetjen, Pacific Northern Airlines and Piasecki Aircraft Corp., Pacific Northern and Piasecki cannot enter into a transaction without CAB approval.

An agreement between various carriers adopted by the International Air Transport Assn. relating to North Atlantic specific commodity rates.

ORDERED

Flying Tiger Line's authority to operate two round-trip charter flights for the Army-Navy Social Club amended to change the European originating point from Stuttgart to Frankfurt.

West Coast Airlines final mail rates set at the rates proposed by the Board in its show cause order for the period Nov. 1, 1953 to Oct. 31, 1955, and the period beginning Nov. 1, 1955.

Operating authority of 62 Alaskan pilot owners terminated since they failed to respond to CAB inquiries concerning their operations.

CAB order for Slick Airways and the Flying Tiger Line to show cause why the Board should not disapprove certain agreements between the carriers and trucking companies and air freight forwarders reissued with errors and omissions corrected.

DISMISSED

Capital Airlines petition for reconsideration of a 1952 CAB order denying the carrier's application for exemption authority for a New York-Atlanta-New Orleans route. The petition is moot since the carrier has subsequently been awarded the route.

DENIED:

American Airlines petition for stay of the effectiveness of the joint loading provisions of Part 296 of the Economic Regulations. Other questions raised in the petition were deferred for further consideration.

Motion of the City of Vandalia, Ill., for consolidation of its application for air service with the Seven States Area Investigation.

Delta Air Lines and Eastern Air Lines joint petition for reconsideration of earlier CAB action denying the two carriers permission to intervene in the Seven States Area Investigation.

Shortlines

▶ **Allegheny Airlines** flew 5,934,000 passenger miles in May, an increase of 23% over May, 1955, traffic. Passenger traffic in the first five months of the year was up 24% over the same period last year.

▶ **Lufthansa** has taken up its option on seven Vickers Viscount 810s, bringing total Viscount sales to 323.

COCKPIT VIEWPOINT

By Capt. R. C. Robson

Technique Saves Time

Voice communications, as everyone well knows, are a critical part of the movement of aircraft. Since those of us who use the radio have criticized just about all phases of the problem, except the users, might it not be wise to look at our own techniques? Is it possible that certain revisions in our radio procedures could cut down unnecessary wordage and relieve frequency congestion?

At the risk of incurring the wrath of my fellow airmen I can't seem to ignore the fact that as a group we are not always the most polished and brilliant of radio announcers. More important, we may fail to realize how great each extra word adds to the overloaded airwaves.

Listen to Tower

For instance, take a major terminal area. Washington will do. Approaching aircraft will call the tower at about the 25 mile range—near Baltimore. This call may consist merely of an identification such as, "Washington Tower, this is Make-Believe Airline 999." The tower will acknowledge this call and wait for 999 to reveal its position and intentions. Then the tower will provide the landing information, active runway, wind, traffic and next required reporting point. This Alphonse and Gaston sequence can take as much as a minute or more.

Which may not be necessary. Usually if the pilot will listen to the tower frequency for a short while he can learn the important data for himself. Then his initial contact can indicate that he knows the runway, the wind and all the rest.

This may seem like trivia. But where else can we look for immediate communications relief? One major airport recently had 67 arrivals in one hour (not an unusual occurrence) and well over half of these were bunched into 30 minutes. An attempt to carry on a leisurely conversation with each aircraft would only result in chaos. A policy of more listening and less talking in such cases might help.

Pilots Half the Story

Of course, the pilots are only half the story. Let us assume that our Flight 999 has landed on Runway 36 at Washington National. Towards the end of his landing roll he will be advised by the controller to "Make a left turn and contact Ground Control on 121.9 megacycles." Since the terminal is but a few hundred feet to the left, a left turn does seem appropriate. In fact, many pilots have wondered if anyone really thought they might make a right turn and taxi for 25,000 miles to reach the ramp?

As for tuning to 121.9, this also is a normal procedure. There are only a few airports in the country where any other channel is used. It would seem that this gem of wisdom could also be eliminated, unless of course the pilot seems obviously unfamiliar with the local ground rules or the frequency has been changed.

Now, lest the reader think that all pilots and tower operators are bumbling fools to go through such a rigmarole in the midst of the daily crisis it should be added that this is exactly what the radio-telephone procedures call for. Written back in the days of leisurely flying, this official repartee is now in sad need of revision.

There seem to be many standard conversations which could be shortened or eliminated, as indeed they must be at the major terminals today. We do not have to develop into a breed of staccato speakers and ordinary courtesy and good manners should not be sacrificed. But certain revisions in "the book" might be a big help.

20 M.P.H. HIGHER CRUISING SPEED GUARANTEED FOR YOUR DC-3

New "Maximizer" kit not only gives you a guaranteed speed increase without an increase in horsepower, but improves the safety, range, payload and economy of your DC-3

Here's how this new "Maximizer" works A newly-designed, completely integrated system of engine cowling, engine baffles, oil cooler ducting, wheel well doors and tail wheel well closure, and exhaust system is installed.

Each of these modernizing improvements acts to reduce drag. Single engine rate of climb is greatly improved, fuel consumption decreased, range increased, payload improved,, and cruising speed is raised a guaranteed 20 miles per hour!

The AiResearch Aviation Service Division is the exclusive world-wide distributor for the "Maximizer" kit. For further details, send for our free brochure

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Airline Income & Expenses—April 1956

	Passenger Revenue	Mail Revenue	Express Revenue	Freight Revenue	Subsidy	Total Operating Income	Total Operating Expenses	Net Operating Income (before taxes)
DOMESTIC TRUNK								
American	$20,732,612	$539,744	$318,305	$1,058,271		$22,942,397	$19,138,337	$3,804,060
Braniff	3,546,265	98,987	52,012	84,821		3,842,271	3,433,185	409,086
Capital	4,576,699	92,947	71,977	81,815		4,891,359	4,814,846	76,513
Colonial	550,476	8,271	4,257	14,049	$21,101	611,592	621,238	−9,645
Continental	1,298,509	33,809	10,911	33,489	101,537	1,512,933	1,446,224	66,709
Delta	5,520,854	118,986	86,598	152,709		6,007,550	4,953,160	1,054,390
Eastern	18,644,336	297,988	147,087	201,484		19,700,848	15,317,812	4,383,036
National	5,163,717	83,849	26,678	114,707		5,638,712	4,226,509	1,410,203
Northeast*								
Northwest	3,389,070	108,900	76,253	159,801		3,823,680	4,014,750	−191,069
Trans World	12,200,181	306,999	246,921	387,574		13,366,999	14,215,244	−848,245
United	17,459,272	724,307	326,768	697,927		19,380,644	18,703,723	676,921
Western	2,184,658	65,945	28,349	35,981		2,343,048	2,167,102	175,945
INTERNATIONAL								
American	362,232	12,327	163	53,709		444,263	383,742	60,521
Braniff	387,326	113,544		26,221		551,403	543,750	7,652
Caribbean Atlantic	138,526	1,385		4,315		150,429	118,035	32,394
Colonial	198,762	482		1,353	4,515	211,435	179,833	31,601
Delta	350,796	5,180		17,021		380,293	377,556	2,737
Eastern	909,496	19,170		12,342		1,041,671	775,267	266,404
National	351,583	3,491	1,345	6,356		383,213	288,074	95,139
Northwest	1,178,564	475,178	3,836	205,956		1,956,319	1,873,229	83,290
Pan American								
Alaska	274,000	18,000		70,000	111,000	611,000	637,000	−26,000
Atlantic	6,526,000	689,000		619,000	203,000	8,457,000	8,266,000	191,000
Pacific	4,062,000	587,000		466,000	57,000	5,576,000	5,106,000	470,000
Latin America	4,772,000	251,000		761,000	512,000	6,853,000	6,836,000	17,000
Panagra	1,199,406	73,573		118,767		1,627,273	1,583,323	43,950
Trans World	4,164,162	572,623		264,014		5,269,224	5,430,851	−161,627
United	1,012,244	33,428		17,114		1,078,464	866,503	211,961
LOCAL SERVICE								
Allegheny	328,363	9,273	9,423	3,294	131,219	489,910	530,038	−40,128
Bonanza	147,667	3,068	2,163	2,472	98,384	260,195	238,252	21,943
Central	91,721	3,136	1,166	2,526	169,488	289,136	280,102	−10,966
Frontier	231,697	226,130	3,706	16,975		487,796	477,492	10,303
Lake Central	107,599	2,897	5,261		111,160	229,628	222,717	6,910
Mohawk	350 402	4,097	3,500	5,715	51,463	423,842	445,087	−21,245
North Central	455,132	14,304	12 240		110,570	598,541	595,365	3,176
Ozark	245 173	176,399	6,294	2,923		434,573	439,890	−5,317
Piedmont	400,232	7,819	3,749	5,095	116,133	555,232	613,213	−57,981
Southern	163,021	6,898	5,146		124,447	304,031	317,997	−13,966
Southwest*								
Trans-Texas	232,236	7,530	4,159	7,289	194,248	450,054	457,392	−7,337
West Coast	176,470	3,054	2,170	3,336	121,441	310,891	320,283	−9,392
HAWAIIAN								
Hawaiian	347,485	3,165		58,886		432,503	412,543	20,020
Trans Pacific	145,732	525		6,063	4,397	156,733	189,792	10,532
CARGO LINES								
Aerovias Sud Americana*								
Flying Tiger	45,069			701,254		1,129,022	884,719	244,303
Slick				1,454,192		1,454,192	1,379,017	75,175
Riddle*								
HELICOPTER								
New York Airways	21,361	2,580	3,092	2,375	119,645	150,871	139,802	11,069
Los Angeles Airways	7,791	11,366	9,159		55,443	84,596	85,672	−1,076
Helicopter Air Service*								
ALASKAN								
Alaskan Airlines	118 611	36,714	573	62,075	141,465	523,125	472,573	50,562
Alaska Coast	37,871	8,962	5,301		31,469	92,022	87,711	4,311
Byers Airways	2,020	1,362		1,307	4,487	11,489	8,306	3,182
Cordova*								
Ellis Air Lines	28,072	4,227		5,241	22,120	66,512	74,774	−8,261
Northern Consolidated	48,114	29,133	349	20,299	97,108	407,273	348,714	58,558
Pacific Northern*								
Reeve Aleutian	24,167	23,470		2,749	10,168	74,112	70,230	3,881
Wien Alaska	38,603	37,567		16,698	75,855	434,328	366,576	67,751

*Not available
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board

WORLD'S FASTEST FIGHTER POWERED BY NEW G-E J79 TURBOJET

In quantity production for USAF's Lockheed F-104A, General Electric J79 delivers most thrust per pound of any engine in its power class

F-104A HIGH SPEED AND LOW WEIGHT ARE DUE IN LARGE PART TO G-E J79'S SMALL SIZE, HIGH THRUST OUTPUT

J79 TEST BED RUN-UP. Emphasizing fast development, G-E engineers brought the entirely new J79 jet engine from drawing board to hardware in record time. Close G-E teamwork with USAF helped cut entire year from development cycle

Potent new addition to the U.S. Air Force's might, the ultrasonic Lockheed F-104A is an extremely versatile aircraft. It is equally effective as a light-weight day fighter or as an interceptor. Rugged ground support missions are also within its operational scope.

The spectacular design features of the F-104A demand a versatile engine: light weight, efficient, powerful. And today, the F-104A has that engine—General Electric's new J79.

Outstanding performance is built into this new G-E turbojet. The J79 incorporates radical new features which assure efficient operation at both sub- and supersonic speeds. It delivers more thrust per pound of engine weight than any other jet in its power class. It is now in quantity production at General Electric, where more than 30,000 G-E J47's and J73's have been produced since 1948.

"The J79, with its light weight and high thrust, was selected for the F-104A because it was the only engine that would give the aircraft this much performance," states Robert E. Gross, Lockheed President. Teamed with the F-104A, the J79 permits still another dynamic step forward in American airpower. General Electric Company, Cincinnati 15, Ohio. 25-6

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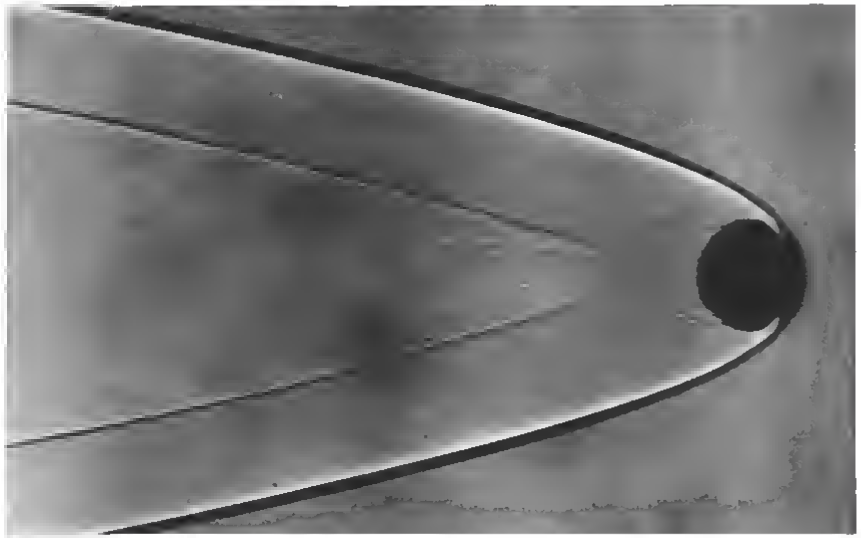


HYPERSONIC SPHERE speeding from light gas gun at Ames Aeronautical Laboratory at 10 000 mph shows blunt body flow pattern. Strong detached bow shock wave increases in thickness downstream. Flow field between shock front and boundary layer is clearly defined.

Gas Dynamics, Part I:

Key Tool for ICBM, Satellite Studies

By David A. Anderton

The intercontinental ballistic missile and the earth satellite vehicle have forced a sudden and rapid growth in the newest branch of the aeronautical art: gas dynamics.

Neither of these vehicles flies in the traditional air of the aerodynamicist.

The ICBM flashes downward through air that is changed to a strange mixture of molecules surrounding the missile like a shroud. The missile heats up terrifically. The skin erodes, oxidizes, melts and vaporizes. A highly ionized layer of gas shields the missile from the reception of radio signals and prevents it from telemetering any answers back to the ground. These effects can be described generally, but they must be calculated by hypersonics before the overall performance of the ICBM can be predicted with any degree of accuracy.

In contrast, the satellite orbits in a rarefied medium, colliding occasionally with a stray molecule of gas. Its life is determined by these collisions which gradually slow down the satellite and nudge it out of its orbit. This life time can't be calculated exactly. For Project Vanguard, the IGY satellite, the best figures available bracket the period between several days and several weeks. This first approximation to the life expectancy was calculated by using the empirical data and theory of supersonic dynamics. The satellite will add to the limited store of that knowledge.

These two extremes of aerodynamic flow problems—hypersonics and supersonic aerodynamics—mark the major areas in the study of gas dynamics.

- **Hypersonics is the study of the dynamics of gases at very high speeds.** The lower limit of velocity for the hypersonic range has been set arbitrarily at Mach 5 although actually there is no difference in the fundamental flow patterns between ordinary supersonic Mach numbers and those above five. There are differences in the gas which is doing the flowing caused by the enormous energy transfers to the molecules as they pass through the shock wave.
- **Supersonic aerodynamics is the study of the dynamics of gases at very high altitudes or extremely low densities.** It should not be associated solely with supersonic speed because it is quite possible to have subsonic flow conditions in the realm of supersonic aerodynamics. There are differences in the fundamental flow patterns between supersonic aerodynamic conditions and either subsonic or supersonic aerodynamics. The air no longer acts like a continuous medium, but behaves like a random collection of molecules bouncing like agitated ping pong balls.

Research in both these fields is moving ahead at a quickening pace. Theoretical studies, the traditional approach to understanding natural phenomena, were started many years back based on inconclusive evidence and were carried through by assuming everything except the responsibility for the validity of the answers.

Tests demanded an inventive approach to the techniques and apparatus, because conventional wind tunnel or free flight methods were incapable of reaching the extremes of speed and density required. Out of armament laboratories came the light gas guns to fire projectiles at hypersonic speeds. From nuclear physics the ideas of accelerators were expanded to larger mass accelerators to stimulate free flight. The shock tube, an old discovery predating the twentieth century, was resurrected and has been developed as a most useful tool. Firing ranges and wind tunnels were modified and operated with gases other than air to simulate higher Mach number flight.

Over the past five years, both theoretical knowledge and practical proofs have grown geometrically, each feeding the other in the familiar regenerative cycle of research and development. The crash programs on the ICBM and the satellite added greatly to the impetus for the studies.

The results show today. Empirical data, even though incomplete, exists for prediction of performance of both ICBM and satellite. The gaps in the knowledge of these specialized phenomena are being closed.

HYPERSONICS

For years the general concepts of the ICBM were well understood. It was to be a monstrous, multi-stage, rocket powered missile carrying an enormous nuclear warhead or perhaps one of the rumored thermonuclear types, which were even bigger. In size it would be comparable to a tall building. Total rocket weight would be prodigious.

Studies of such an ICBM were made leisurely at an academic pace. The basic thinking was that such weapons were one or two decades distant, waiting on advances in warhead design.

But in 1951 occurred a major exploitation of nuclear techniques: the development of the "midget" thermonuclear warhead.

The weight of the required ICBM delivery system dropped to a fraction of its original value. Development pace of the ICBM suddenly rushed on.

And then the scientists and engineers came to a second dam: the complete lack of knowledge surrounding the problems of re-entry.

Hotter than the Sun

An ICBM will hurtle downward towards its target at speeds greater than Mach 10, perhaps approaching Mach 20 as a reasonable limit. Simple calculations show that the missile could become incandescent. Stagnation temperatures, which are calculated by assuming that the oncoming air is completely stopped and all of the energy of its motion changed to heat, figured to be above the 10,000F level of the surface of the sun.

But skin temperatures are not stagnation temperatures: the stagnation temperature is a theoretical maximum and everything else in the region is at a lower value.

So the problem of re-entry can be simply stated: The missile gets hot. How hot does it get?

The answer to that question is found in the thin layer of gas which proved to be a major barrier between ICBM ideas and their practical applications.

That layer is the flow field between the shock wave and the nose of the missile.

In a tiny fraction of an inch, air ceases to be the familiar terrain of molecules of oxygen, nitrogen and inert gases that scientists have mapped over the years. The strong compression across the shock wave forces tremendous energy changes—measured as temperature and pressure changes—jarring loose some of the outer electrons and ionizing the gases.

Through the Shock

The temperature of the nose cone is determined uniquely, at any time, by the physical mixture of those particles behind the shock and by the nature of the boundary layer.

For various reasons the nose of an ICBM will be blunt. The shock wave will be detached from this nose and fixed ahead a short distance in space. This flow geometry can be thought of in terms of four areas.

- **Shock front**—generally assumed as infinitely thin and a mathematical discontinuity, but actually of finite thickness. This front is not in equilibrium; it is a transition region between equilibrium conditions in the air ahead of the shock and the changed gas mixture behind it.
- **Shock layer**—the region between the shock front and the boundary layer. This layer is the new mixture different from air ahead of the shock.
- **Boundary layer**—the thin region of nearly static gas near the surface.
- **Wake**—the turbulent volume of gas enclosed by the boundary layer and originating from the base of the missile.

To understand what goes on as the air passes through these different flow regions, look at an individual molecule.

A molecule has certain degrees of freedom. Its motion can be described in relation to three axes: up and down, forward and backward, left and right. These are the three degrees of translational freedom.

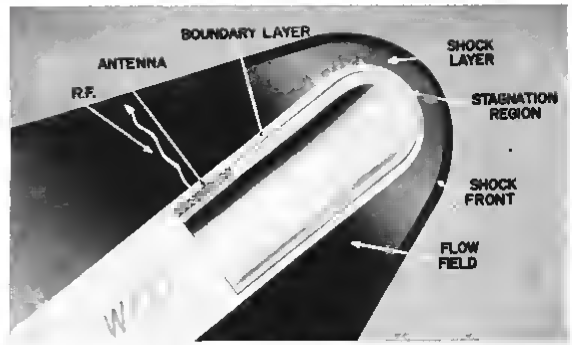
It can revolve around three mutually perpendicular axes for another three degrees of freedom, called rotational. A molecule also can vibrate for still another degree of freedom. The tendencies to dissociate and ionize are additional degrees of freedom.

Each of these degrees is associated with some energy level. Translational and rotational are the lowest; vibration and excitation are at higher levels.

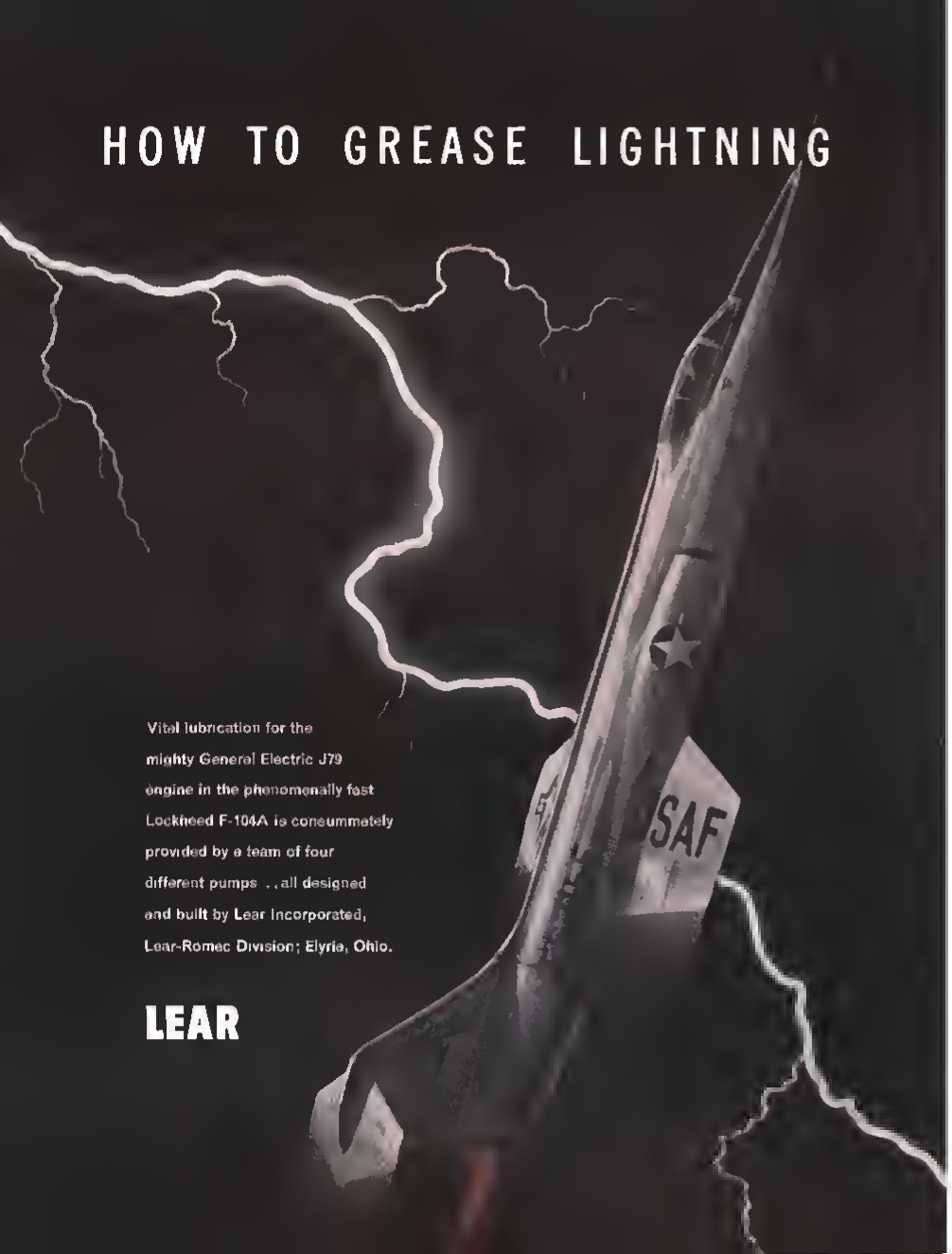
Air molecules are considered to have five degrees of freedom under normal conditions: three translational, one rotational and one vibrational.

The passage of a molecule of oxygen or nitrogen through the shock front starts a complicated physical and chemical chain of events that begins with energy transfers. The strong compression of the shock converts translational energy to vibration and excitation levels within the molecule. It takes definite amounts of energy and finite amounts of time to do this. While the transfer is being made, the temperature of the molecule drops in steps.

The time period for equilibrium to



HYPERSONIC FLOW model shows principal portions of the flow regions around a hemisphere-cylinder combination. Compare sketch with spark photo of real thing (on preceding page) to identify separate regions of photograph.



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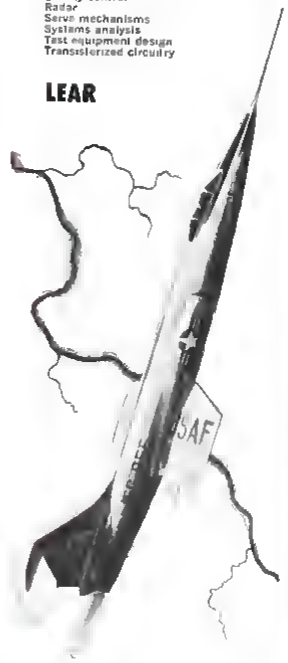

be established is called the relaxation time. It is about 0.0001 seconds for oxygen and about 0.00002 seconds for nitrogen.

Behind the Shock

Classical hydrodynamics is used to calculate the conditions just behind the shock front. For a missile making Mach 20 at 100,000 ft., the peak temperature level is 35,000F., equilibrium level is much lower, at about 13,000F. The pressure is 650 times the ambient and the density is about 13 times that of the air at 100,000 ft.

The shock front has a thickness of a fraction of a millimeter on the axis of the nose cone, and it increases toward the trailing portion of the shock. Thickness for any shock front increases as altitude increases and as shock strength decreases.

The composition of air is changed by its passage through the shock and into the shock layer, where it reaches some sort of thermodynamic equilibrium. Instead of the familiar mixture of about four-fifths nitrogen, one-fifth oxygen and traces of rare gases, the air in the shock layer of a Mach 20 missile is about half atomic nitrogen, one quarter molecular nitrogen and one quarter atomic oxygen.

Nitric oxide will also be present to some extent. Its influence is felt on radiation, ionization and the reaction rates of the gas in the shock layer.

The shock layer is assumed to be what the aerodynamicist calls an inviscid flow field, where fluid viscosity, diffusion and thermal conductivity—called the "transport" properties—don't affect the flow properties significantly. This may or may not be true.

The aerodynamicists work with three subdivisions of this flow field:

- **Stagnation region** at the front of the nose cone where there is negligible velocity of the air flow along the axis.
- **Subsonic region,** where the flow with respect to the surface of the nose cone is subsonic. This covers the volume between the stagnation region and a conical surface about 45 degrees off the missile axis in a forward direction.
- **Supersonic region,** where the flow is supersonic with respect to the missile surface and remains that way downstream.

Calculations are extremely complicated and lengthy for these flow fields. Detailed investigation of the flow processes had to wait for the availability of computing machines; one authority believes that even the very latest and largest such computers are not fully capable of handling the problem.

One of the complications in calculating what happens in the shock layer is determining the proportions of dissociation and recombination that will take place. At Mach numbers between about 10 and 14, electronic excitation and ionization are minor portions of the process.

Dissociation is the major change in that speed range: the molecules of nitrogen and oxygen break down into atomic forms. It takes energy to do that and that energy is supplied in the form of heat taken from behind the shock. This reduction of heat could alleviate somewhat the aerodynamic heating of the skin.

The catch is that atoms have greater thermal conductivity than molecules and also will recombine—giving up some of their energy in the form of heat—if they strike the surface of the missile. These two factors tend to increase the heating of the skin. So the proportion of dissociation and its rate must be calculated to determine the heating of the nose cone.

Another problem is that of determining where the transition to ionic flow occurs; obviously it depends on knowing the local velocity of sound, which is not very well known for air that has become partially dissociated.

Finally, the basic assumption of the inviscid flow field may not be right at all. The composition of the gas in the shock layer varies for high and low shock velocities, and the molecules and atoms will show various electronic energy levels at the higher shock strengths. So it is entirely possible that the viscosity, diffusion and thermal conductivity of the gas mixture may not correspond to those for air. Their effects on the flow field may not be small; and if they are not small, then the assumption of inviscid conditions does not apply and the calculations are grossly inaccurate.

Knowing the transport properties in the high temperature range is the key to the assumption of inviscid conditions. But transport properties are not determined well enough for the peculiar conditions of hypersonics and are very difficult to determine.

Radiation and Transmission

Radiation from the shock layer to the nose cone of the missile is one of the major causes of skin heating. Calculation of this amount of heating depends on the emissivity of the radiating source. Does it act like a black body, or like a shiny one? It is of greatest importance to know the composition of the shock layer, because each different mixture will have different radiation characteristics.

As speed increases, ionization of the air increases and the number of electrons in the shroud around the nose goes up. The power required to transmit radio energy through that ionized layer is determined by the electron dis-

tribution. The number and spacing of electrons depends on the structure of the flow field and on interactions between electrons and other particles.

The power requirements for telemetry from an ICBM test round may be so great as to rule out that method of data-gathering entirely. Conversely, if radio transmission or reception to or from the missile is a requirement, then the missile speed will have to be limited by the degree of ionization in the shock layer.

Boundary Layer

The problem of the boundary layer in hypersonic flight generally is similar to those for supersonic and subsonic conditions with a few exceptions.

Both velocity and temperature in the boundary layer decrease as the distance from the surface decreases. At the surface, the boundary layer speed is zero and the temperature is much lower than the 13,000F free stream equilibrium value.

Thickness of the boundary layer is generally very small. With dissociated air right near the surface, there may be diffusion towards the surface of such magnitude to carry some dissociated particles to the surface. This affects the heat transfer, requiring that the detailed structure of the boundary layer be determined before heating can be calculated.

The ideal is to keep the boundary layer laminar because the thickness is greater than in a turbulent boundary layer. With turbulence, the hot shock layer is nearer to the missile surface and the heat transfer is much greater.

One of the problems facing the designers of the ICBM warhead therefore is to devise a shape that will allow the flow to remain laminar instead of making the transition to turbulence. One way that might be used is to rotate the nose section at fairly high speed. This tends to keep the boundary layer laminar to much higher Reynolds' numbers than usually possible. The technique was suggested by experiments made about 20 years ago on rotating discs to get laminar boundary layer data extended further along the speed range.

SUPERAERODYNAMICS

Final flow region is the turbulent wake behind the missile. So little is known about the structure of this flow field and so little work has been done in determining its characteristics that aerodynamicists are unable to cope with the detailed consideration of the wake. For that reason, most of the problems of the wake are lumped together and solved as an effect rather than causes, generally by measurement of the base drag of a missile model in a wind tunnel or in free flight.

Diametrically opposed to the hypersonic world is the superaerodynamic region where air is rarefied. At extreme altitudes the relative dimensions of flow change and new patterns of flow structure are established.

Conventional aerodynamics began as an offshoot of hydrodynamics, where the working fluid was considered as incompressible and non-viscous. Air also was assumed to act like a continuous, homogeneous medium, incompressible and non-viscous.

By the late Thirties, compressibility corrections were being used to alter the old fundamental curves and data of aerodynamic design. Mostly empirical, these corrections were refined as more and more wind tunnel and accurate flight test data became available.

Aerodynamics itself made a transition a little later. The air had to be assumed as the compressible medium it was, but it was still all right to assume that it was also a continuum.

The criterion for continuity in a medium such as air is the mean free path of a molecule. This is the average distance that any molecule travels before colliding with another molecule. At sea level conditions the mean free path is a very small fraction of an inch. As altitude increases, the atmospheric

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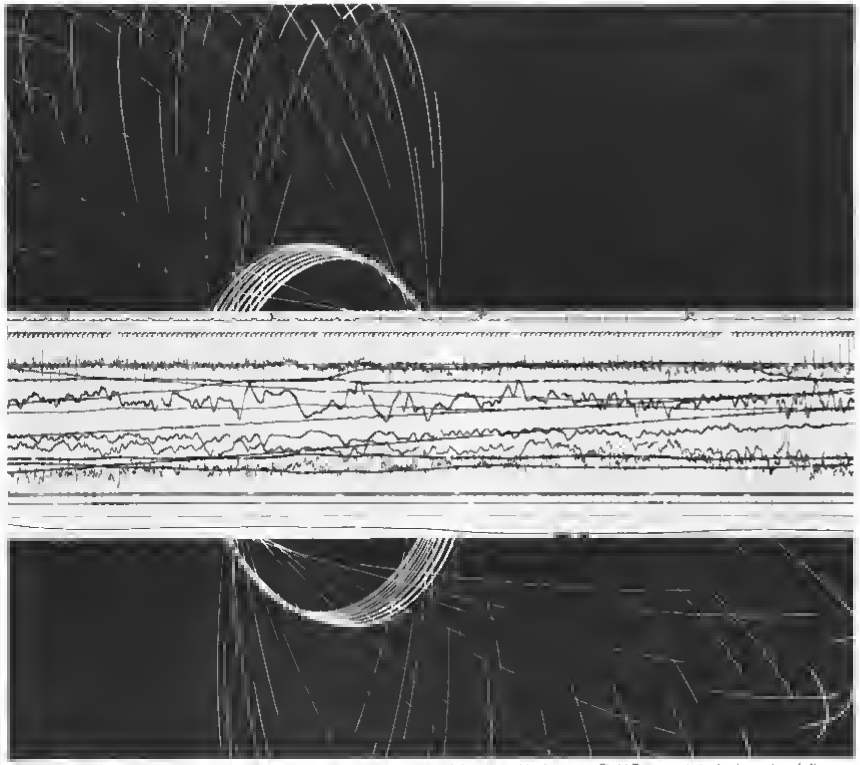

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density drops because there are less molecules in a given volume of air. With less molecules, the chances of collision are reduced and the molecules travel further before impact. Eventually, the air density is so low that a molecule has an chance of collision and so leaves the earth's atmosphere.

With the arrival of extreme-altitude flight, aerodynamics again had to reorient its thinking. Air could no longer be treated as a continuum but had to be considered as a region where the individual molecules set the flow pattern.

The aerodynamics of that region is called superaerodynamics.

Criterion

The mean free path was used to set dividing lines for two areas of superaerodynamic study.

- **Slip flow**—where the mean free path is on the order of a fraction of the boundary layer thickness. Normal sea level free path of a nitrogen molecule is less than one one-hundred-thousandth of an inch. normal sea level boundary layers are measured in much larger fractions of an inch and might be as much as a major fraction.
- **Free molecule flow**—where the mean free path is large compared to the body size. One arbitrary limit has been set at the point where the path is ten times the body diameter.

For a research vehicle like the Aerobee rocket, for example, the slip flow region would be encountered at somewhere between 20 and 50 miles. Free molecule flow would occur above about 80 miles altitude.

The relationship between body size and ambient altitude in determining the boundaries of these regions shows in considering an altitude research vehicle such as a piloted rocket ship or pilotless rocket. Instrumentation depending on air pressure or motion would be the first to make the transition to the slip flow regime because of the smaller physical dimensions involved. A slim rocket would be in the slip flow range before a fat-bellied research plane, a small nose rudder would make the change before a large wing would.

Slip Flow Regime

The pioneering consideration of superaerodynamics was presented a decade ago by H. S. Tsien, since returned to Red China. For the past nine years the major amount of superaerodynamic work has come from two sources: Ames Laboratory of the National Advisory Committee for Aeronautics, and the University of California at Berkeley. Ames has concentrated on the problems of free molecule flow, and Berkley on the slip flow.

The major characteristic of slip flow is that the boundary layer is different

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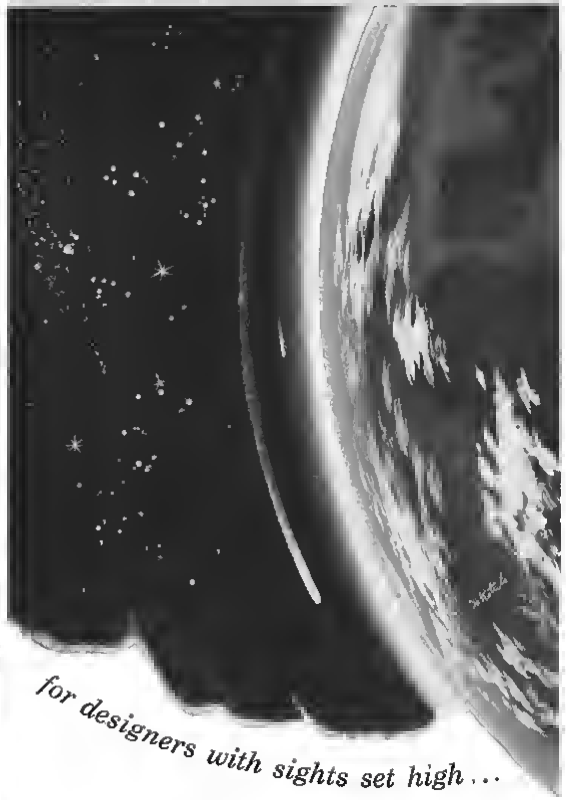

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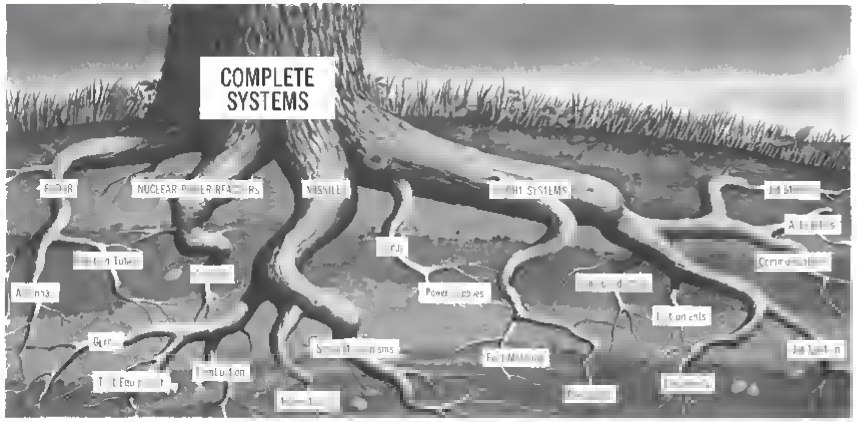

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altogether. The air in contact with the surface of the missile is not at rest, as it is in the static layer of conventional aerodynamics. The boundary layer is much thicker, which means proportionately higher skin friction.

The work at Berkeley has produced a collection of empirical data for predicting the aerodynamic and heat transfer characteristics of some simple shapes such as cones, flat plates, spheres and cone-cylinder combinations. Berkeley scientists found that these characteristics are quite different from the corresponding values under conditions of higher pressures.

But what remains uncertain as whether or not all the difference can be charged to slip flow.

The nature of the slip flow region is such that it does not lend itself to theoretical analysis readily. Consequently the real contributions will continue to come from wind tunnel tests.

Free Molecule Flow

In this flow region the missile can be thought of as traveling in a molecular beam. The molecules strike only the missile, their likelihood of collision with each other is so remote that it can be ruled out of the flow equations.

The problem then becomes one of simple energy transfers between the molecules and the missile, and can be analyzed by classical Newtonian mechanics. Lift and drag in free molecule flight can be determined, knowing the molecular velocity and applying statistical mechanics to determine the distribution of molecular collisions with the body.

One unique problem of free molecule flight is the absorption of air molecules by the missile surface. At the extremely low pressures of high altitudes, a molecule of gas can be captured by the surface and held for some indefinite period of time before being re-emitted again in a completely random manner. The extent to which this happens determines the energy transferred during a given time from the molecular beam to the missile, thus helping to determine the lift and drag forces on the missile.

The immediate importance of the intercontinental ballistic missile as contrasted with the blue sky aspects of the satellite nowhere shows up as sharply as in the availability of data in the two extreme regions of gas dynamics. The literature of hypersonics is growing at increasing progression, that for supersonic aerodynamics is increasing at a much slower rate.

Part of the reason for this is the availability of test facilities. Hypersonic and supersonic aerodynamic simulation requires ingenuity. Some of the techniques will be discussed in the second part of this series.

Valve Talk

FOR WM. R. WHITTAKER CO., LTD.
BY MARVIN MILES

(Rerun by special request)

If his desk is loaded with correspondence . . . If his secretary's waiting patiently with a half-completed letter in her notebook . . . If he's busy on the phone, with three or four calls holding . . . If there are visitors in his office and others lined up outside . . . he's a buyer—the guy who for a modest salary spends millions of dollars for his aircraft company each year, saves the firm untold expenditures and gets blamed for all shortages, late deliveries, and other troubles, with rarely a pat on the back for a job well done.

He's a man who is paid for a 40 hour week, although he averages more like 50 hours -- including Saturdays. He has to, for he's expected to complete the mountain of work that's piled on his shoulders.

His salary ranges in the vicinity of $500 to $700 a month but in any one year he may write 10,000 purchase orders totaling perhaps $15,000,000 to buy thousands of items from hundreds of different suppliers.

And in this buying he may, by skill, ingenuity and knowledge, be responsible for savings in the millions. In fact, a favorite pastime among aircraft buyers is to tote up and compare the savings they have made for their companies.

A dedicated man, personally proud of the job he accomplishes, the average equipment buyer has been at his task for 10 years or more, having won the job through experience in follow-up, expediting and assistant buyer classifications.

He knows metals and materials, products, producers and prices. Hundreds of contacts are at his fingertips and within his own organization he works with engineering, materiel, inspection, receiving, shop, shipping, the laboratories, the release group, traffic, etc.

Everyone with whom he deals expects him to be – and by and large he is – an endless source of information on each of the thousands of items he procures.

It's an ulcer building job, but the buyers seem to enjoy the challenge of juggling dozens of phone calls each hour, perhaps fifteen office visitors each day. They gripe about the bales of paper work involved, but in the same breath they thank their fates for dependable vendors the efficiency of their secretaries and assistants, the expediters, the follow up men and the assistant buyers who handle thousands of cluttering details.

Clobbering their work continually are such major and minor irritations as re-scheduling, engineering changes, revised specifications, impossibly short lead times for new procurement, failure of suppliers to meet shipping schedules, foul-ups by inefficient vendors, price increases, salesmen who hang around the office to chat after completing their business, visiting dignitaries who use up valuable time and -- worst of all -- corny jokes. These boys have heard them all, so if you've got one it better be good.

In rare instances buyers receive tempting offers by unscrupulous vendors who hope to buy business with gratuities.

But you'll find most every buyer is a 'company man" and not about to sell out his integrity, his pride and his firm to the glib salesman of an inferior product. The vendors who attempt to bribe are consistent losers.

There's only one worry about a good buyer as far as his company is concerned. Because he's capable, quick-thinking, analytical and smooth-talking, with years of experience to boot he can sell as well as he can buy. Suppliers recognize this and many a buyer has reversed his field to turn salesman and apply his abilities for a vendor in the perfect counterpart of his original job.

Yet, as I have said, these capable, hard-working men seldom receive the kudos they deserve. Not that their accomplishments aren't appreciated. It's just that they are expected to do a top job and they invariably measure up to expectations.

From Whittaker, then, a pat on the back to the buyers.

"Well done!"


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Test Pilot Report on Boeing Jet 707

By Russell Hawkes

Garden City, L. I.—In spite of its higher performance and greater weight, the Boeing 707 jet transport is less work to fly than equipment currently in service, according to A. M. "Tex" Johnston, chief of flight test for Boeing.

Johnston amplified earlier reports of the 707's handling characteristics (AW Nov. 21, 1955) in an address before a meeting of eastern members of the Air Line Pilots Association here.

The 707 is somewhat harder to land in a cross-wind, than current aircraft, he said. This is characteristic of airplanes with the swept wing. The upwind wing is more efficient than the one downwind because the air flow across it is chordwise while the flow across the downwind wing is spanwise. The difference in lift thus produced imparts a downwind rolling moment.

Johnston said the 707 is easier to handle in this respect than other swept wing types he has flown because its spoilers can destroy much of the lift of either wing and the pod pylons have some effect as fences limiting spanwise flow. The rolling moment is not great enough to endanger a wing tip or a pod. Its effect is to lengthen the landing roll-out. With the down wind landing gear bearing most of the airplane's weight, the upwind gear produces less braking action because of its reduced traction.

The landing gear tread of the 707 is somewhat narrower than that of current airline types because it is necessary to retract the big four-wheeled bogies into the fuselage. There is no engine nacelle on the wing offering storage space for them. This relative narrowness does not affect the cross wind capability of the plane according to Johnston.

FLIGHT ENGINEER'S PANEL on 707 is studied by flight test chief A. M. "Tex" Johnston.

Brake System

The 707 has a brake anti-skid system to prevent a wheel or bogie bearing a lighter friction load than the rest of the wheels from being stopped by brake pressure, thus wearing tires unevenly. This occurs—without the anti-skid system—when a cross-wind partially unloads the upwind bogie when icy spots are encountered on the runway, when blacktop runway surfaces melt in spots on a hot day, etc. Given the weights at which the 707 will operate, no pilot could hope to sense wheel skid and make pedal corrections, Johnston said.

The thrust reversers to be installed on the 707 will be about as effective braking units as the reversible pitch propellers now in use, he reported. They have an efficiency of about 50%. Tests of a fixed version of the reverser mounted on the number two engine have been limited to a taxi speed of 80 knots because at higher speeds the asymmetrical reverse thrust scrubs the nosewheel sideways. Reverser control will be a separate lever on the control pedestal because Boeing wants to avoid a complicated throttle linkage.

A prototype of Boeing's noise suppresser mounted on a single outboard engine for tests has been found to reduce the noise level 12 decibels or 17% from the noise level of the unsilenced engine. Johnston showed a film of the empty 707 holding altitude in a fly over at 290 knots with three engines out and only the silenced engine operating.

Regarding the performance of the 707 at altitude, Johnston said that an angle of bank of 45 degrees is necessary to make a standard rate turn (three degrees per second) at the expected cruise altitudes and an indicated air speed of 205 knots. He suggested that for the sake of passenger comfort it may be desirable to use half-rate turns in holding patterns and instrument let-downs. He acknowledged that the resultant expansion of the holding pattern may cause a traffic control problem.

Lateral Control System

The lateral control system of the 707 includes spoilers, inboard cruise ailerons and outboard low speed ailerons. The system gives the airplane a rate of roll of about 36 degrees per second at cruising speeds.

The control linkage to the outboard ailerons is broken when the flaps are up and they remain fixed in neutral with the inboard ailerons and spoilers providing all lateral control at high speeds. This configuration was chosen to avoid aileron reversal which occurs at high subsonic Mach numbers. The area and travel of the inboard ailerons are small to limit the possibility of reversal but they provide adequate control in the event of a spoiler failure.

The swept wing configuration of the

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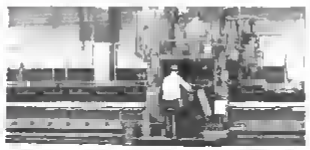

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airplane increases lateral controllability because a small amount of slip or skid causes flow on the forward wing to be more nearly chordwise than that on the aft wing. The resulting lift differential tends to roll the airplane into balanced flight. Lateral and directional controls are both effective at stalling speed.

All controls are manual with aerodynamic boost except the spoilers which are hydraulically powered. The spoilers can be extended differentially for lateral control or symmetrically as speed brakes. While in use as speed brakes they can be used for lateral control by differential retraction. Spoiler extension does not produce a strong pitching moment.

Pilot Technique

The landing attitude of the 707 is nose high. Recommended technique is to push the nosewheel on immediately after touch-down and extend the spoilers. These actions spill the lift off the wing and place 80% of the airplane's weight on the wheels for effective braking immediately.

Johnston said that while the 707 changes trim radically as speed changes, there is little effect on trim from power changes. This means that full power can be applied quickly for a go-around without obliging the pilot to fight heavy control forces. Trim change caused by air flow separation at high subsonic Mach numbers is also relatively slight. A small negative pitching moment is experienced rather than usual pitch-up.

Johnston said that in early test phases a considerable buffet was caused by separation at the rudder. On one occasion the buffeting was violent enough to rip the flight engineer's panel from its mounts. A fix has since been made, he reported.

Fin area of the 707 has been limited to prevent too sudden recovery from turbulence induced yaws. The propeller-driven Stratocruiser recovered with a snap and shudder that was sometimes unsettling to passengers.

There is no washout in the wing to the 707. Camber varies from station to station along the span of the wing and this is believed adequate to prevent tip stalls in normal operation.

Johnston said that climb out in the 707 is made at 300 knots until increasing altitude brings the Mach number indication for that speed down to Mach .8 (about 30,000 feet). The remainder of the climb is made at Mach .8. At maximum gross weight the 707 reaches 35,000 feet in 30 minutes.

The 707 is capable of extremely rapid let-downs in the event of a pressurization failure. The procedure is to reduce power, extend the spoilers to decelerate to 270 knots and extend the gear. With the wheels down, the pilot may accelerate to the landing gear placard speed of 310 knots and let down at 14,000 feet per minute with a cabin angle no greater than 30 degrees.

Constant flow oxygen masks for the passengers drop out of the ceiling if pressure fails. Oxygen quantity is adequate to supply a full load of passengers for a period equal to roughly half the time range of the airplane at 20,000 feet. Range is penalized by cruising at any lower altitude.

New Tool for Electra

Major airframe and skin structure components for the turboprop-powered Lockheed Electra transport will be shaped on a new radial draw former, believed to be the largest ever built. The machine will form parts up to 33 ft. long and will produce curved shapes in two planes and full circular pieces up to 88 in. diameter.

The 46-ft 9-in. x 30-ft 7-in. machine will have electronic pressure and tension controls. Being built by Cyril Bath Co., Solon, Ohio, it will cost some $275,000.

A similar but smaller machine will be delivered by Cyril Bath soon to Bell Aeronautical Co., San Diego, at a cost of about $150,000. Sikorsky Aircraft, Bridgeport, Conn., has installed another model at a cost of about $200,000.

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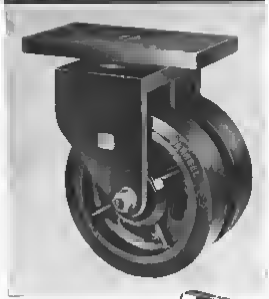

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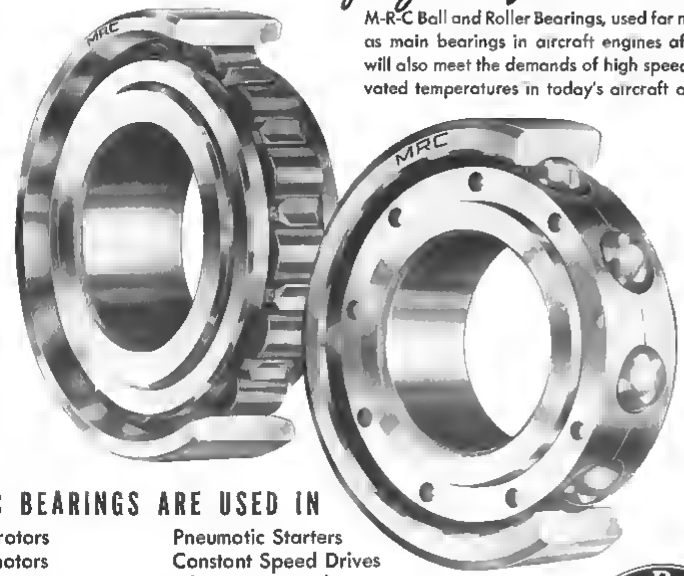

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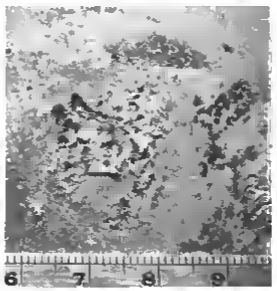
Armour Imitates Heat, Dust Erosion

Surface heating and erosion by airborne and meteoric dust are being simulated at the Armour Research Foundation of the Illinois Institute of Technology by firing dust particles at metal surfaces near the muzzle of a shock tube. Impact blasts molten metal off the model. It appears possible to accelerate particles to speeds as high as 15,000 fps by varying shock tube parameters.

Preliminary tests indicate that thin metal shields may not provide the necessary protection for satellites or aircraft and missiles at high altitudes. An 008 inch copper plate has been penetrated and the surface of a half inch aluminum plate has been severely damaged by dust propelled at speeds of 4,000 fps.

Research in this area is made difficult by the lack of exact data on the quantity, composition, and size of dust in the upper atmosphere. Some scientists have revised upward earlier estimates of the quantity. Orbital velocities of the dust may be as high as 30,000 fps and missile velocities will be about 15,000 fps.



HIGHSPEED DUST pits aluminum badly.

PRODUCTION BRIEFING

Military propeller output decreased 27% last year (over 1954) and civilian propeller output decreased 2%, according to the Department of Commerce. Total value of aircraft propellers and parts shipped by plants manufacturing complete propellers totalled $120 million.

Cold extrusion of titanium has been successfully accomplished by the Battelle Memorial Institute, Columbus, Ohio, for ARDC's Wright Air Development Center, Ohio. Simple round bars of pure titanium have been reduced 40-70% in area, increasing their strength from 25 to 60% of full work hardened value. First the billet is coated with phosphate-fluoride to prevent the highly reactive titanium from forming alloys with the tools. Then it is punched through the extrusion die under a pressure of 100,000-280,000 psi. A petrol-

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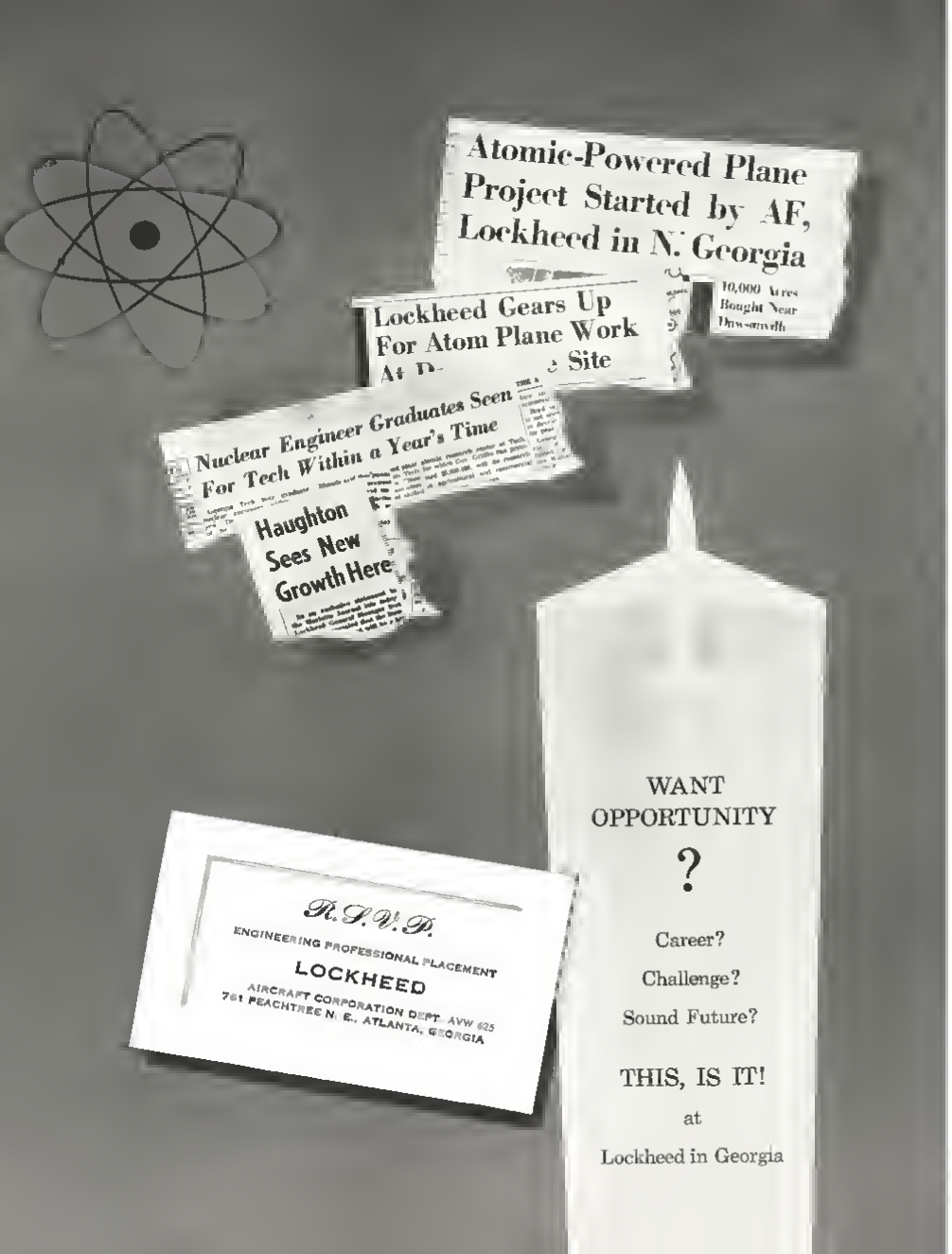

cum base moly disulfide-graphite lubricant is used to inhibit seizing. On the subject of titanium drawing, AVIATION WEEK has learned from M. F. Judkins, Firth Sterling Co., that, surprisingly enough, Super Kem Tone, the interior house paint, makes a good lubricant.

Publication PB 111707, Spot and Seam Welding of Titanium and Titanium Alloys, may be ordered from U. S. Department of Commerce, Washington 25, for $4.75. It contains information on welding processes for commercially pure titanium sheet, oxygen-nitrogen titanium base alloy, Ti-100A and 8% manganese titanium base alloy.

Chemical milling cuts the weight of some aircraft parts 75%. U. S. Chemical Milling Corp., Culver City, Calif., reports use of a new etching process economical for short runs and much more versatile than conventional machine methods.

Selected European technical articles relating to all fields of manufacturing and production are being translated, digested and sent out on a monthly basis, the Department of Commerce announces. Subscriptions to this service are handled by the O. E. E. C. Mission Publications Office, 2000 P Street, N. W., Washington 6. The rates are $24 a year or $2.50 a single issue.

Hycon Mfg. Co., Pasadena, Calif., has established a Camera and Instrument Division.

Two M.I.T. faculty members have formed Tyron, Inc., Dr. Harold Mickley and Ernest Neumann announce that their firm, located in Cambridge, Mass., will investigate mechanical and chemical processes.

The American Brass Co. is building a new aluminum mill in Terre Haute, Ind.

The Tube Manifold Corp. has opened a new 32,000 sq. ft. plant for fabricating tubular products.

Axelson Manufacturing Co., Los Angeles, has started work on an 110,000 sq. ft. expansion at Montebello, Calif., intended to consolidate the company's aircraft landing gear and component endeavors.

Titeflex, Inc., as part of their $1,500,000 move from Newark, N. J., has enlarged their Springfield, Mass., plant from 250,000 to 300,000 sq. ft.

Alloy Precision Castings Co., manufacturer of investment castings, has leased a 23,000 sq. ft. plant at Cleve-

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A few of the typical shapes of metal parts which have been Hydrospun

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Under high compressive forces, rollers form an inexpensive flat blank or simple preform to the shape of a rotating mandrel, usually completing a part in one pass. Movement of the roller brackets is controlled by hydraulic tracer and makes possible irregular wall thickness and curved wall shapes. Strength characteristics are improved and finish is excellent.

Savings Take Many Forms

Forming by this economical method obsoletes many chip cutting operations with resulting savings in labor, material and machines. One manufacturer has made savings of 100 lbs. of critical high temperature alloy in one jet engine part alone. Another development on a missile part shows savings of 40% in material over draw die method and saves weight of the finished part by control of wall thickness.

A wide range of metals has been successfully Hydrospun and, as the above photograph shows, an unlimited variety of tubular, conical and hemispherical shapes is possible. Ask us about ways to put this Hydrospin to work for you in solving your manufacturing problems on hard-to-make, highly stressed parts. We can show you how to produce a better part at a definite cost saving. Write for brochure today. Address Dept. A.

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Vickers Servo Pump Systems

Provide rapid and accurate response to minute electrical or mechanical signals

The Vickers Servo Pump Unit shown at the right is a signal-controlled, variable delivery, positive displacement, reversible flow oil hydraulic pump. In combination with a rotary or linear hydraulic motor, it forms a signal-controlled hydraulic transmission for remote control operations and high-response servo systems.

The servo transmission may be considered as a power amplifier when viewed from the electrical signal input of about five watts, to the mechanical power output of several thousand watts. Various sizes of transmissions have been built, having output capacity ratings from one to four hundred horsepower. The servo pump develops only that pressure required to move the load — which means reduced pressure over the greater part of the system life since peak loads occur only infrequently in the majority of systems. This greatly reduces power losses and minimizes heat rejection.

Any type of prime mover of sufficient capacity can be used to furnish the power input — electric motor, auxiliary drive pad on an airplane engine, air turbine, hydraulic motor, etc. Substantially constant speed is desirable.

Variable Pump Volume Controlled by Signal

Heart of the servo pump unit is the Vickers Variable Stroke Hydraulic Pump. This is usually a nine-cylinder pump housed in a pintle-mounted yoke. Varying the yoke angle varies piston stroke, hence, output volume from zero to maximum in either direction of flow. A stroking piston actuated by a pilot valve varies the yoke angle according to signal.

Low Control Power Requirement

Power for control purposes is low in a servo pump unit because metering valve action is confined to the volume-regulating system which is a low power level (100 to 300 psi) hydraulic system separate from the power transmission hydraulic circuit although a part of the pump unit. This volume-regulating system controls piston displacement and direction in the power pump which can operate at pressures up to 3000 or 4000 psi. Pressure drop across ports of a metering valve, with its inherent losses, is avoided in the power transmission system. Final power output from the pump is determined by the volume of flow which the volume-regulating system demands and by the actual resistance of the load — is not dependent upon pressure drop methods of control.

In a control system employing this servo pump, the variations in gain resulting from load change are negligible compared to those which may occur in a similar circuit controlled by a valve metering directly in the power line.

Constant Displacement Hydraulic Motor

Flow and pressure generated in the hydraulic pump are carried by tubing with no intermediate valving to the hydraulic motor or linear actuator. The fixed stroke hydraulic motor provides torque directly proportional to pressure and speed directly proportional to flow rate.

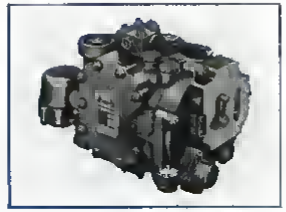
High Power-to-Weight Ratio

The servo pump unit and its associated hydraulic motor are designed for high power-to-weight ratio, high torque-to-inertia ratio, low inertia of rotating parts, and high resonant frequency.

Typical Example

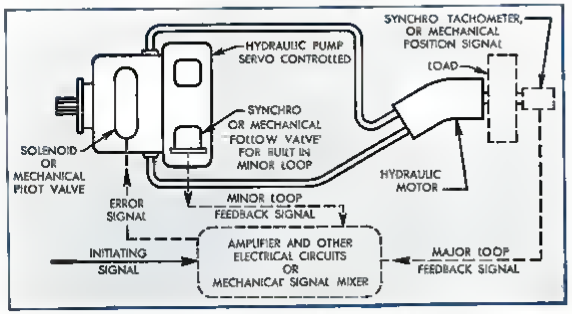
High power to weight ratio—3.75 hp/lb (motor only)
High torque-to inertia ratio—3.5 x 10⁶ lb in /sec²
Low inertia of rotating parts— .052 lb in²
High resonant frequency— 20 cps (entire system)

Other advantages are reliability and versatility of application. The smooth, stepless speed changes and ability to hold position against any variation in load are additional reasons why this unit is a desirable resource which can solve many design problems.



Important among the applications of Vickers Servo Pump Units is extremely fast and accurate positioning of gun turrets on aircraft. Another is actuation of the exhaust nozzle for jet engines, here the servo pump's characteristic of providing at all times only sufficient power to meet the momentary demand minimizes the power loss and therefore the heat rejection. The greatly reduced average pressure level in this type of system prolongs the life and improves the reliability of all components.

For further information, ask for Bulletins SE-15 and SE-18 or get in touch with your nearest Vickers Aircraft Application Engineer. He can arrange for an engineering team to consider your problem and propose an optimum solution.



SIMPLIFIED DIAGRAM illustrates a servo control system employing Vickers Servo Pump Unit and Constant Displacement Hydraulic Motor. This system accepts initiating signals (either electronic or mechanical, depending on type of system), compares them with feedback signals from load and (through controlled changes in direction and volume of fluid pumped to motor) corrects the load as required. For added accuracy and stability, a minor loop providing signals proportional to rate of flow may be added. This may either be built into the pump in the form of a mechanical "follow valve" which results in modulating the flow as a function of the out signal to the pump, or may be a synchro which feeds a signal proportional to flow rate into the amplifier. The controlled output may be either a function of the position or velocity of the load.

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land, Ohio. The company uses frozen mercury as an intermediate step in obtaining ceramic shell molds to cast precision radar and aircraft control components.

Allegheny Ludlum Steel Corp. has agreed to furnish technical know-how to Midvale-Heppenstall Co., Philadelphia, on the subject of the latter's new production of consumable electrode vacuum remelting of steel and ferrous group base alloys. Allegheny Ludlum says that the high temperature superalloys produced by this method at its Watervliet, N. Y., plant have been in great demand for jet engines.

Robertshaw-Fulton Controls Co. is constructing a new laboratory building at its Aeronautical Division, Anaheim, Calif., as an expansion of its guided missile interests.

First quarter earnings for Aeronca Manufacturing Corp., Middletown, O., are reported at $4,993,554 with net income at $150,688. The company's backlog is estimated at $31,000,000 and the 50,000 sq. ft. plant addition is nearly ready for occupancy.

Recent completion of a 25,000 sq. ft. Radioplane building marked one of the first steps in Northrop's plan to develop a large aircraft manufacturing center at El Paso, Texas.

Gordon Enterprises, camera manufacturing firm of North Hollywood, Calif., has finished a fourfold expansion begun one month ago with the acquisition of an additional 42,000 sq. ft. building.

F-104 wing and J57 component subcontracts are expected to insure continued high level of productivity at Temco Aircraft Corp., Dallas, Texas, which had first quarter sales of $19,621,602, an increase of 19% over last year's quarter.

American Research Corp., Bristol, Conn., started work on an 8,500 sq. ft. building at Farmington, Conn., to accommodate increased demand for their environmental test equipment.

Lockheed has started work on a new Missile Systems plant at Sunnyvale, Calif.

Fischer & Porter have commenced work on a new million dollar office building at their Hatboro, Penna., works.

Aeroquip's subsidiary, Aero-Coupling Corp. has recently opened a subsidiary of its own in Burbank, Cal., to form, weld and braze tubular components for aircraft and industrial tubing.

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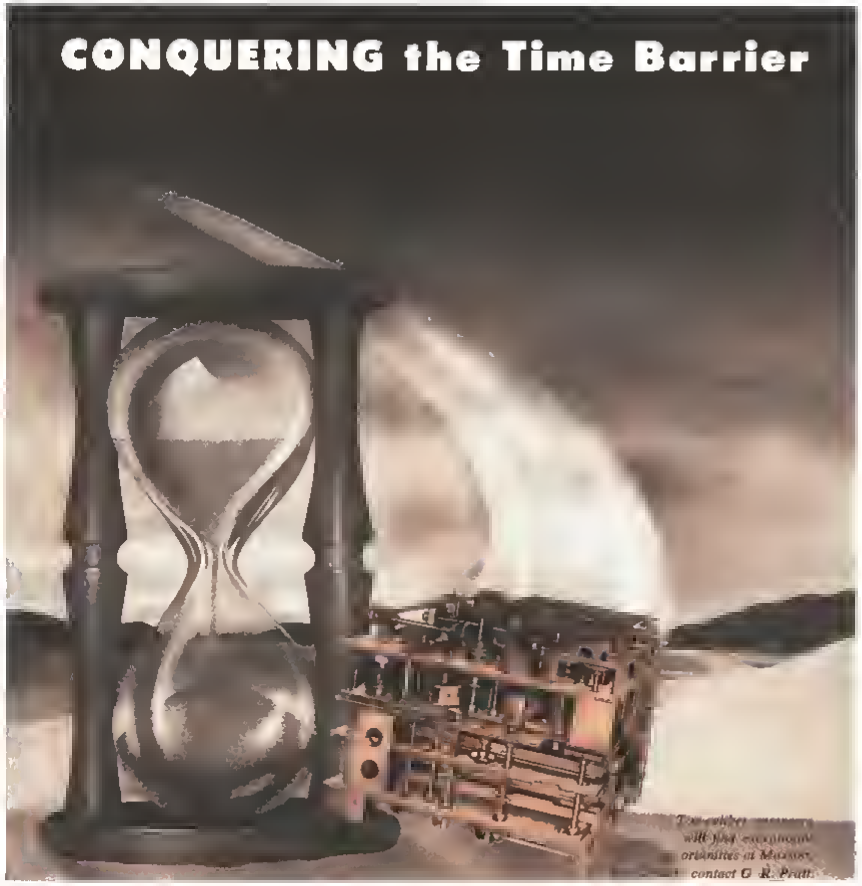

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Control System for 1975 Traffic Outlined

By Philip J. Klass

Boston—One concept of a Common System navigation and traffic control for 1975 calls for a nation wide network of ground radars and full integration of Common System and the SAGE air defense system

The possible 1975 system, resulting from an Air Navigational Development Board systems engineering approach to updating the basic Common System concepts enunciated in 1947 1948 by RTCA s Special Committee 31 was disclosed by James L Anast at the spring assembly of the Radio Technical Commission for Aeronautics

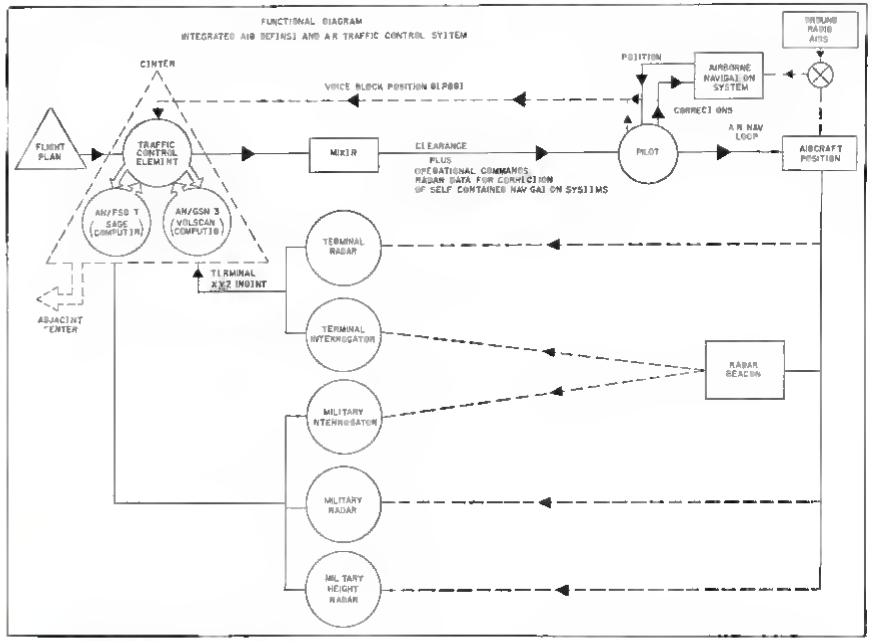
Developed while Anast was chief of ANDB's Systems Engineering Group, the concepts take on special significance because of Anast s recent appointment as Systems Planning Advisor to Edward P Curtis the President s special assistant for Aviation Facilities Planning

The ANDB s postulated system for 1975 was based on the following basic premises

- **An traffic will triple** by 1975, based on Civil Aeronautics Administration and Port of New York Authority estimates
- **Positive (IFR-type) control** of all air traffic will be required in some high density areas such as New York Using estimates of 1975 traffic, this means the New York area will have to accommodate 465 operations per hour under peak conditions
- **Combination area and airways** control will be needed coupled possibly with "expressways" for high speed traffic movement Area control requires information from a greater air space area, more ground communication and data processing facilities
- **SAGE** air defense facilities will be available for integration into a combined defense and traffic control system and that adequate SAGE coverage is obtainable throughout the national airspace
- **Minimum airborne equipment** is desired
- **Equitable handling** of individual aircraft, regardless of the amount of airborne equipment carried
- **Airspace segregation** by category of aircraft can be used, providing that safe and speedy control can be equitably distributed to all airspace users
- **Ground derived information** will be used as basic traffic control information within the limits of practicability

Based on these assumptions, ANDB s advisory team postulated the following picture of what the Common System of the future may look like

Long-range air defense surveillance and height finder radars, supplemented by CAA radars will provide information on all aircraft in the airspace This will require civil aircraft to carry a radar



1975 traffic control system, conceived by Air Navigation Development Board's team of expert advisors, proposes to integrate civil traffic control and air defense SAGE system

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Airwork Corporation
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Montreal, Canada

C. J. Cunnell Company
Newton Upper Falls, Massachusetts

General Aircraft Supply Corporation
Detroit, Michigan

Pacific Airmotive Corporation
Burbank, California

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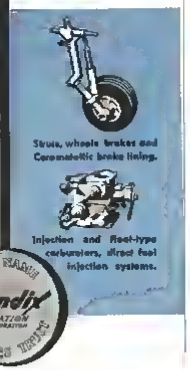
Sounds like a lot to promise, but if you will get in touch with your nearest Bendix Distributor, he will be glad to demonstrate just how the program works.

*TRADE MARK



BENDIX PRODUCTS DIVISION SOUTH BEND, IND.

transponder (beacon), either the more sophisticated multi code unit now contemplated for airline use, or a simple uncoded beacon. Lightplanes might carry a simple corner reflector to reinforce ground-radar echos.

Data from radars will feed into the SAGE AN/FSQ 7 computers, while similar data from civil terminal area radars will feed into Volscan-type tracking computers (AN/GSN 3 return-to-base system). These tracking computers in SAGE and Volscan will keep tab on individual aircraft within the airspace under their control. Information from the computers including aircraft position, altitude, speed and heading will feed into what ANDB calls the traffic control element. This consists of an airspace reservations computer, a symbolic display of airspace occupancy, and the human controllers. (The traffic control element would be located in CAA control centers.)

Automatic Pesting

The airspace reservations computer will calculate each aircraft's estimated arrival time over its next fix, automatically print out a flight strip card which is sorted and automatically displayed in chronological order with other aircraft due over the same fix. When an aircraft leaves the area under control of one center, the reservations computer automatically will transmit its flight plan (via teletype circuits) to the adjacent center's airspace reservations computer which automatically will prepare and post its flight strip.

Data on aircraft not under radar surveillance can be inserted into the reservations computer manually by the human controller.

ANDB expects that one or more of following types of ground-air communications will be employed:

- **Military data link** for interceptor aircraft.
- **Civil data link**, or air traffic control signaling system (ATCSS) as it is usually called, for routine clearance instructions.
- **Voice communications.**

Because SAGE commands to interceptors will funnel through the central traffic control element, they must be given an overriding priority relative to civil traffic control instructions. This is provided by what ANDB calls a "mixer" which blocks civil ATCSS or voice communications when SAGE needs to transmit ground-air instructions.

1975 Navigation

ANDB believes that automatic dead-reckoning computers and/or short term stability inertial guidance systems will supplement present ground-based radio aids, such as VOR/DME and Tacan. Their purpose will be to give the pilot a continuous indication of his aircraft's position, particularly during off-airways flights.

Where lightweight semi-automatic dead reckoning computers are employed, information on aircraft position as established by ground radars will be transmitted automatically at periodic intervals via data link or ATCSS and displayed in the cockpit to permit the pilot to reset his DR computer. Another attractive possibility is to introduce such corrections automatically, as in the recently announced Lear Scan. (AW June 11, p. 71.)

The terminal area will employ Volscan-type automatic scheduling computers which now are designed to assert control when aircraft are 60 miles out. In high density multiple-airport areas, this control might extend out to 100 miles or beyond, Anast believes.

The Questions

A number of questions must be answered before the proposed system could become the official Common System, Anast points out:

- **Can SAGE and Common System** needs be integrated without adversely affecting air defense capabilities?
- **Will this system serve** the needs and meet the desires of all airspace users?

Before the last question can be answered, it will be necessary to make mathematical analyses of such things as distribution of aircraft types from now until 1975, by area, altitude, speed and other characteristics, techniques for combining area and airways control, data transmission rates between elements of the system.

Equally important, Anast believes, is actual full-scale experimentation in the problems of integrating air defense and air traffic control systems. A limited program is now under way in the Boston area.

However, "We won't make too much progress until a single national experimental air traffic control facility is available."

Need Not Wait

Seat's analysis of the system required to meet 1975's needs pointed up presently available techniques and equipment which offer immediate help in solving present problems. Most are compatible with the 1975 system proposed. These include:

- **Twin feed inner stack** systems for single airports as developed by CAA's Technical Development Center.
- **Use of air defense radars** in critical enroute areas by remoting their data to CAA centers. (This currently is under investigation.)
- **Volscan** for use in high density areas.
- **Air traffic control transponders**, currently being readied for CAA evaluation.
- **Airport surface** detection radar at appropriate airports.
- **Air-expressways.**
- **Reserved low-altitude airways** for helicopters and low speed aircraft.
- **High-speed runway** entries and exits.

In addition to research and development of a long-range future common system, Anast believes that the CAA's new five-year plan could well be augmented by some of the foregoing. However, he adds that "to budget for radars, beacons and additional navigation aids is fine, but unless accompanied by a rigorous program of procedural improvement such as that developed by the CAA's Technical Development Center and the USAF's TRACALS project, the Common System will not grow at the required rate."

ANDB Limitations

Commenting on the handicaps under which ANDB has operated, Anast said that it has been "somewhat unsuccessful" in getting its recommendations accepted by participating agencies whose attitudes have range from "tolerance to hostility."

Despite this, and "a mere dribble of funds which compete with the massive military R & D programs in navigation and traffic control," ANDB has taken "action to the limit of our capabilities," Anast said.

Engineering Team

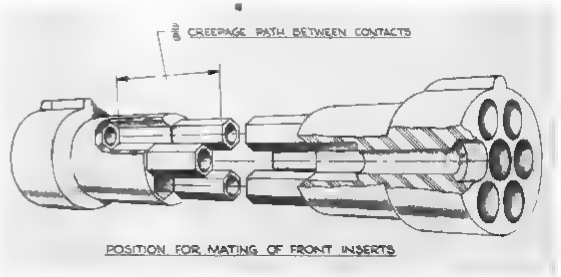
When the re-organized ANDB in 1954 tackled development of an improved Common System capable of meeting 1975's traffic demands—it found a lack of clearly stated definitive requirements and insufficient scientific effort being devoted to synthesis of the future system, White House Adviser James L. Anast told RTCA.

ANDB formed a systems engineering advisory team seat made up of 10 industry and government experts. Seat proceeded to analyze the original SC-31 master plan together with a host of subsequent documents and policy statements issued by the Air Coordinating Committee and other agencies.

"We found basic disagreements between these documents in major and detailed aspects of the system and were unable to synthesize a unique system concept from guidance contained in these documents," Anast said.

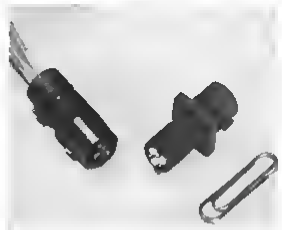
If ANDB were to be able to provide guidance for future developments it had to 'postulate' the Common System of 1975. Anast prefers the word "postulate" to "define" because ANDB recognized that the system might have to be revised as new data techniques, or official policy statements became available.

"The system design had to have inherent growth possibilities without risking radical changes in control philosophy and equipment."



New Miniature High-Altitude Connector

Miniature high-altitude connector capable of use at up to 125,000 ft., employs novel staggered construction (sketch) which gives long (⅛ in.) creepage path between pins despite small connector dimensions. Device is rated for 1,800 v.a.c. at sea level, 800 v.a.c. at 70,000 ft., but reportedly has operated up to 3,500 v. at 125,000 ft. before breakdown. Connector reportedly can withstand 200 G shock and shows no resonance to 2,000 cps. Standard connectors are available with 1, 3, 7, 19, 37, or 61 pins. Manufacturer: R. A. Castell & Co., 740 Salem, Glendale 3, Calif.



COCKPIT (foreground) simulating that of F-102 jet interceptor, and electronics components ready for installation in An Force T-29. Some 13 men are required to test the electronic control system developed by Hughes to test fire control and navigation systems. Once test plane is taken aloft by regular pilot control is shifted to pilot in simulator cockpit in cabin, who flies big plane as though it were a jet. Special nose on T-29 houses antenna of electronic control system

Pilot Flies T-29 From F-102 Mockup

HUGHES' Engineer R. E. Moore in "plane within a plane." Behind cockpit, technician works at cockpit observer's station. Crouching aft, another adjusts computer test equipment

By Richard Sweency

Culver City, Calif.—Hughes Aircraft Co. has mocked up an F-102 cockpit in an An Force T-29. A pilot actually flies the big ship from the fighter cockpit in the plane's cabin. Purpose of the installation is to enable Hughes to check out its fire control and navigation systems in flight, but other possible uses are opening up, such as observance of pilot reactions to various situations during flight.

The installation enables company technicians to install avionic gear, flight test it and record its performance in flight. In cases of subnormal performance or component malfunction, technicians can replace the defective part and attempt to determine what causes the malfunction.

Full instrumentation is provided, utilizing data recording suitable for IBM punch card data reduction.

The T-29 carries a complement of 13 persons including the test pilot who flies the F-102 / T-29, the regular flight crew, and technicians who work with the avionic gear under test.

In addition to the advantage of access to all equipment in flight, the setup provides for longer test periods aloft than could be obtained with an F-102, and at a much lower cost.

The test bed utilizes extensive photographic installations to cross check the avionics systems under test.

Photos are taken and accurate timing checks of the tracking antenna provided for.

Simultaneous cross reference pictures are taken of the ground track target and of the data recording instruments and test panels.

While other crewmen are evaluating the avionics, a psychologist sitting immediately adjacent to the F-102 mock up is able to observe closely pilot reactions toward the various information presentations during flight.

Presently under test is an advanced avionic navigation/fire control system for the F-102A. However, the test bed is capable of handling installations of many types of cockpits and fire control systems from other models of fighters or bombers.

FILTER CENTER

(The following items are based on papers delivered before the recent Spring Assembly of the Radio Technical Commission for Aeronautics at Boston.)

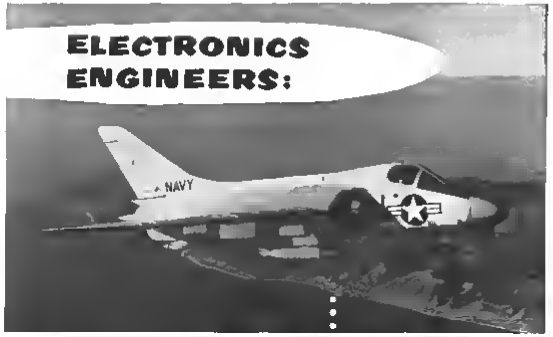
► **BS (Before SAGE)**—Dr. George E. Valley, Jr., associate director of Lincoln Laboratory, describing the chaotic problem of air defense without automatic data processing techniques: "With the number of men tracking radar targets, their supervisor, and the supervisors of supervisors, the amount of communications machinery required to chain all these hierarchies of men together gets to be so large that what one has done is to push the problem back through various layers of radar sets, PPI scopes, tracking officers and the like until finally it has been lost. Having lost sight of the problem one is misled into thinking he has solved it."

► **Radar Shortcomings?**—Speaking of the views held in some quarters that ground radar is not suitable for air traffic control because it is unreliable and not capable of detecting all aircraft, Dr. Valley says: "This is almost entirely because the radars in use are underdesigned for the purpose and are inadequate in theory as well as in practice. It is possible to make radars which in all characteristics would be satisfactory for the air traffic control purpose, just as they can be made satisfactory for the air defense purpose. Moreover, a network of radars set up for air defense will detect all aircraft regardless of whether they are commercial or military, and so it is a waste not to use the information."

► **Don't Blame Engineers**—"Our immediate need (in air traffic control) is not better work from the engineers. Our need is more imaginative work by the planners. We must find means of more accurately forecasting our aviation requirements so the efforts of our development people can be properly directed." Maj. Gen. Gordon A. Blake, USAF, Director of Communications-Electronics.

► **Security Roadblock**—Gen. Blake proposed a more liberal military attitude to speed civil use of new military communication-navigation equipments developed under security wraps. Blake suggested that a special group in the Joint Communications Electronics Committee of the Joint Chiefs of Staff (JCEC/JCS) and a special security cleared civil committee perhaps in the RTCA, could examine new classified developments to see if they had potential Common System use, include such equipment in Common System planning work to promote declassification as soon as its potential civil benefits outweighed security considerations. In answer to an AVIATION WEEK query, Gen. Blake indicated that Doppler auto-navigators,

ELECTRONICS ENGINEERS:



VITAL PROJECTS such as AERO-13 CHALLENGE YOU at Westinghouse BALTIMORE DIVISIONS

In the nose of the Douglas F4D Skyray fighter interceptor is the new Aero-13 Fire Control System developed by Electronics Engineers at Westinghouse—Baltimore Divisions. This improved system makes possible the detection and destruction of enemy aircraft under no-visibility weather conditions. (Photo courtesy Douglas Aircraft Company, Inc.)

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Westinghouse encourages its electronics engineers to continue their education toward both M.S. and Ph.D. degrees. The company pays all tuition expenses.

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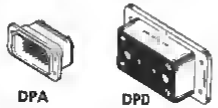

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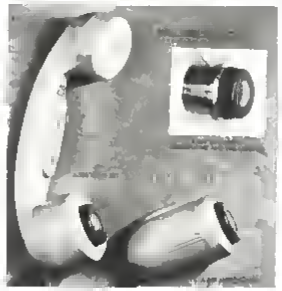
such as the General Precision Lab APN 66 and APN 82, might be declassified for civil use.

► **Situation Snafu**—N. E. Halaby, Vice-chairman of the Aviation Facilities Study Group (Harding Committee) summed up its observations as follows: "We found an amazing network of committees, time consuming coordinating procedures, conflicting departmental interests, confused relationships, preoccupation with current and short range issues and a need for objective, forceful high-level leadership. Coordination has become almost an end in itself." Halaby's personal observations: Politics and economics of traffic control have lagged far beyond the required techniques.

► **Long Overdue**—Air Traffic Control Signaling System (ATCSS), or "private line" as it is sometimes called, for transmitting routine messages from ground-to-air by non-voice communications is long overdue. E. A. Post said. Post, manager of the Stanford Research Institute Radio Systems Laboratory, said that the ATCSS developed by Melpar, which works through existing VHF receivers might be the quickest possible system to implement for civil use.

► **Time Saver**—Recorded weather meteorological information, automatically broadcast at regular intervals from CAA traffic control centers could cut radio spectrum congestion. Post believes. Another idea for relieving communica-



Dynamic Microphone

New transistorized dynamic microphone has noise-canceling design to enhance intelligibility in aircraft use. Three-transistor pre-amplifier, built into mike elsewhere, permits it to be directly substituted for existing carbon microphones without wiring change. New "Transdyne" mike comes in handset or hand-held nylon case. Manufacturer: Remler Co., 2101 Bryant Ave., San Francisco, Calif.

Cherry Adds Aircraft Lockbolts to Fastener Line

Lockbolts for the aircraft industry have been added to the extensive line of aircraft fasteners produced by the Cherry Rivet Division of Townsend Company at its plant in Santa Ana, California.

Cherry Aircraft Lockbolts save weight, offer higher clinching action than rivets, more uniform clinch than bolts and nuts. Their use makes possible an effective seal and rigid joints with high shear and tension values. Fitting-up operations are simplified which helps increase production and results in a lower installed cost.

High production applications of the aircraft industry are especially adapted to the use of lockbolts since they combine the advantages of riveting and bolting—eliminate the disadvantages.

The Cherry Lockbolt line includes a complete range of diameters, grip lengths, and head styles which are designed and produced to meet specifications and requirements of the aircraft industry. They are available in alloy steel and aluminum alloy.

The addition of lockbolts to the Cherry line is further evidence of the continuing program at the Cherry Rivet Division which has as its objective the ultimate in fastening service to the aircraft industry. In fact, all the resources of the Santa Ana plant—experience—technical skill—special equipment—tremendous capacity—the facilities of its research and development department plus the services of its field engineers are devoted exclusively to providing better fastening methods for the aircraft industry.

For information on Cherry Lockbolts, write for new bulletin TCL-111 to Townsend Company, Cherry Rivet Division, P.O. Box 2157-N, Santa Ana, California.

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tions load, and assuring positive altitude separation, is for pilots to use a fixed 29.92 altimeter setting for en route flight switching to a barometric setting only when the aircraft is in the terminal area.

▶ **Airborne Teletype Looks Good**—Post reported that preliminary tests on an airborne teleprinter by North Atlantic carriers look quite promising with successful transmissions up to 1,200 miles from present ground transmitters. Airborne teleprinter would be used for ground-air transmission of weather information and various routine flight instructions, relieving present voice channels.

▶ **On New Terminals**—"Designers of new airport terminals are making it almost as difficult for the passenger to find the right gate as for the pilot," according to Capt. J. D. Smith, Capital Airlines. Airport design, including approach-landing lights, taxiways and high-speed turn-offs will play a major factor in increased airspace utilization, Smith believes. He claims that the U. S. does not have a single airport with what he calls "all-weather capability" despite fact that necessary techniques are available.

▶ **Sorry**—American Machine & Foundry's new air traffic radar display console uses a conventional cathode ray tube. Characters are formed on the tube by beam writing techniques and symbol generating elements. AMF's radar display does not employ the Convair Charactron tube (AW May 28, p. 75).

Dry Screen

Printed circuit boards can be printed, etched, and processed in 14 minutes instead of the usual 4 to 8 hr. by means of new dry screen process which eliminates baking step, according to Dry Screen Process Co. Company's new Mark III press can handle copperclad laminates of any thickness in sizes up to 22 x 28 in. at the rate of 200 per hour. When piece comes off press, it is ready for immediate etching, company says. Address: 801 Brighton Rd., Pittsburgh 33, Pa.

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices.

HEADQUARTERS WILKINS AF STATION, Shelby AF Depot, Shelby, Ohio

Los Angeles Automotive Works, Inc., 1020 Towne Ave., Los Angeles 21, Calif., miscellaneous spares for Type A4 17 ton hyd axle jack (#200-411080) $1003 ea., (PR WL-547860) $31,417

Scaffold Equipment Co., P. O. Box 8780, Pittsburgh 21, Pa., truck roll nose cowl canner mfd IAW USAF Dwg 50J8005 177 ea. (IFB 33-602-56-21) $59,764

United Steel and Wire Co., 27 Fonda St., Battle Creek, Mich., miscellaneous spares for B4 and B5 maint platform 16814 ea. (PR 57876) $71,033

Lord Mfg. Co., 1635 W 12th St., Erie 6, Pa., mounts and insulators 75200 ea. (PR 704012-1, 704031-1, 704256-1, 704261, 704262) $26,565

Lear, Inc., 110 Ionia Ave., Grand Rapids, Mich., actuators power units and data, (PR SA-45893 and SA-563561) $91,918

Maxson Instruments, Div. of the W. L. Maxson Corp., Long Island City 1, N. Y., control unit assembly 305 ea., (PR SA-611431) $319,118

Sundstrand Aviation, Sundstrand Machine & Tool Co., Rockford, Ill., frequency and load control P/N 629570 transmission and governor assemblies M 62056R (PR PE-073043-1 and 073042-2) $49,404

General Electric Co., Waynesboro, Virginia, voltage regulators and data (PR PE-635081) $505,564

Lord Mfg. Co., 1635 W 12th St., Erie 6, Pa., mounts 69980 ea. $40,539

Minneapolis-Honeywell Regulator Co. Inc., 1200 E. Evans Ave., Denver, Colorado, galvanometer helland type M 100-350 100 ea.; galvanometer helland type M 400-120 40 ea.; galvanometer helland type M 100A 30 ea. (Contract Nr. AF 331001) 2177) $37,000

The Uebtroff Co., 1633 W Second St., Davenport, Iowa, misc spare parts for type J47 acft eng dolly 20047 ea. (PR 547858) $69,800

Air Logistics Corp., Hammond Mfg. D Div., 3600 E. Foothill Blvd., Pasadena 8, Cal., spare parts for MB-1 (D30-210) oxygen servicing trailer 10057 ea. (PR WL-547858-1) $77,197

American Air Filter Co., Inc., Herman Nelson Div., Moline, Ill., spare parts for BT-400 type H-1 heater and BB-102 type MA-1 trailer (PR WL 547904) 54470 ea. $48,984

Anchor Coupling Co., Inc., 342 N. 4th St., Libertyville, Ill., parts for E2 and F3 oxygen servicing trailer 11132 ea., $47,789; 338 ea., $1,807; 2790 ea., $26,117 (IFB 33-605-58126 BL total $75,713

Acme Aluminum Alloys, Inc., 21 N. Findlay St., Dayton, Ohio, runway barrier type MA-1A 38 pr $742,032; runway barrier type MA-1A 20 pr $278,245, total $1,021,278, funds in the amount of $204,255 are committed and reserved for spare parts, (PR WL 546481)

Lord Mfg. Co., 1635 W 12th St., Erie 6, Pa., insulators IAW Spec MIL-I-5432C-(ASG) 143540 ea. (IFB 33-602-56-90 B) $52,330

TOPEKA AF STATION, Topeka, Kan.

Sipi Metals Corp., 1720 N. Elston Ave., Chicago 22, Ill., alum alloy ingots, 173000 lbs. (IFB 14-064-56-479) $82,876

Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif., compound emulsion cleaning 57,10 gl., $28,000

Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill., Magnaflux emulsifier developer and oil 13440 gl. $52,056

Carbide and Carbon Chemicals Co., 30 E. 42nd St., N. Y. 17, N. Y., methyl alcohol, 209458 gl., $104,088

Carbide and Carbon Chemicals Co., 30 E. 42nd St., N. Y. 17, N. Y., deicing fluid 145310 gl. (IFB 14-604-56-r92) $128,755

Reliance Chemical Co., Lee Terminal-Standiford Field, Louisville 13, Ky., deicing fluid 154680 gl., (IFB 14-604-56-a32), $143,707

AIR FORCE MISSILE TEST CENTER, Patrick Air Force Base (ARDC), Fla.

International Telemeter Corp., 2000 Stoner Ave., Los Angeles 25, Calif., additional equipment for contract No. AF 08(606)-1015 (PR No. FP-1(55)-316) job $230,824

Cubic Corp., 2841 Canon St., San Diego 6, Calif., improvement and expansion of the COTAR system, expansion of engineering services to be furnished, modernization of the general provisions on Contract AF 08 (606)-705, (PR No. FP-1(55)-246 and -209), job, $424,731

Collins Radio Co., 855 35th St., N.E., Cedar Rapids, Iowa, impedance conversion unit (PR No. FP-1(56)-275) job $36,205

Canoga Corp., 4944 Sepulveda Blvd., Van Nuys, Cal., increase in funds allotted (C.O. No. 5 to Contract AF 08 (606)-70) $80,000

Consolidated Electrodynamic Corp., 300 North Sierra Madre Villa, Pasadena, Cal., recorder 7CAC-NL728501-5 6 ea., magazines 7CAC-NL611157-28 4 ea. (PR No. FP-1(56) 310) $85,324

Ralph M. Parsons Co., 617 S. Olive St., Los Angeles 14, Calif., seventeen (17) telemetry decommutation systems (PR Nos. FP-1(56)-224, FP-1(56)-200, FP-1(56) 314, job, $504,000

Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif., five (5) Coleman comparator ballistic film readers (PR Nos. FP-1(56)-312, FP-1(56) 204) job $173,375

J. P. Seeburg Corp., 1500 N. Dayton St., Chicago 22, Ill., twelve (12) receiver-recorder stations, (PR No. FP-1(56) 295) job $192,795

Convair Div., General Dynamics Corp., San Diego, Calif., design, fabrication and installation of interim impact predictor instrumentation system (PR FP-1(56)-300) job $70,000

OKLAHOMA CITY AMA, Tinker AFB, Okla.

Adel Precision Products, Div. of General Metals Corp., 10777 Van Owen St., Burbank, Calif., pump assy emergency fuel, (RFP 250-031-R-56-8432) 1 item $38,148

B. N. Bailey and Associates, 143 S. Norton Ave., Oakwood Station, Los Angeles 4, Calif., pump assy fuel booster type B-24 (RFP 282-031-1-OC-608117), 2 items $75,000

Marquette Metal Products Div., Curtiss-Wright Corp., 1145 Galewood Dr., Cleveland 10, Ohio, packing motor shaft (RFP 288-03F CC-690120) 25 items $73,738

Pioneer Aero Service, 3304 Burbank Blvd., Burbank, Cal., pump assy fuel booster type B-24 (RFP 232-031-0-0C608117) 1 item $31,722

Joy Mfg. Co., 338 S. Broadway, New Philadelphia, Ohio, fan vaneaxial fixed null V-brsl (RFP 257-03F-609109 and 0C650356) 30 items $33,505

Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich., pump reciprocating motor assy hych., (RFP 338-031-3-OC-691602) 2 items, $521,650

Douglas Aircraft Co., Inc., Tulsa Div., Tulsa, Okla., modification und IRAN of twenty (20) each RB-47E and thirty-four (34) each B-47E type aircraft (IFB 0C-737050, 0C-777550C-1, 0C-737550C-2, 0C-737055C-3), job $1,500,000

Chandler Evans Div., Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn., diaphragm fuel pump (RFP 292-031-2-OC-691690) 10 items $30,274

Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Conn., spring fuel pump valve control (RFP 270-031-3-OC-691684) 117 items, $167,287

Burhmon Wholesale Co., 1073 Clinton Ave., N. Rochester 21, N. Y., washer diaphragm (RFP 300-031-3-OC-691546) 7 items $53,004

Alco Valve Co., 865 Kingsland Ave., St. Louis 5, Mo., motor-DC series wound (RFP 242-03F-OC-640427), 30 items $25,328

South Wind Div., Stewart-Warner Corp., 1514 Drover St., Indianapolis 7, Ind., heater assy aircraft (RFP 289-03F-SB510103) 2 items $39,779

Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Ohio, Spring-Hyd pump, (RFP 326-031-3-OC-691530),

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200 items, $138 095

Adel Precision Products Div. of General Motors Corp., 10177 Van Owen St., Burbank, Calif., pump assy-hyd gear (RFP 280 031-1-OC-055353), 4 items $51 301

Adel Precision Products, Div. of General Metals Corp. 10111 Van Owen St., Burbank Calif., screw-machine steel cad pl fillister head 40080 PSI (RFP 332-081-1 OC-085354), 68 items $92 504

ROME AF Depot, Griffiss, AFB, Rome N. Y.

Electro-Voice, Inc., Cecil & Carrol Sts. Buchanan, Mich., microphone dynamic M-34/AIC 4000 ea., microphone M-32/AIC 7510 ea. (RFP 30 035 56 4190Q), $502 048

Hazeltine Electronics Corp. 59 25 Little Neck Parkway, Little Neck 62 N. Y., modification kits AN/UPA-35 586 ea. (RFP 30 035 56 4223Q), $202 170

Craig Systems Inc., 90 Holton St., Danvers Mass., base radar set turntable MT-1806/FPN 21 ea. base section turntable radar set MX-1804/FPN 21 ea., (RFP 30-535 56-4552Q) $632 258

Radio Receptor Co., Inc. 240 Wythe Ave., Brooklyn N. Y., keyer—FRN 1 2 3 and 4, 53 ea., gear spur—FRN 1 2 3 and 4 53 ea., gear worm—FRN 1 2 3 and 4 53 ea., (RFP 30 035 56 4227Q) $21 695

General Aniline & Film Corp., Ansco Div., Binghamton N. Y., film 11" x 14" 125 pkg film 20" x 24" 230 pkg, film 4" x 5", 10000 pack, (RFP 30-035-56 4452Q), $26-112

Bendix Aviation Corp., Red Bank Div., State Highway 35, Eatontown N. J., regulator (IFB 30-535 56 1158) 401 ea., $92-746

Eastman Kodak Co., 343 State St. Rochester 4 N. Y., film 16mm x 50' reversal mfg processed 1228 mag, film 16mm x 100 reversal mfg processed 3248 roll film 16mm x 100' reversal mfg processed 2148 roll (RFP 30 035 56-4454Q) $30 515

E. I. DuPont de Nemours & Co., Photo Products Dept., Wilmington 98 Del., film, 8mm X 1000 fine grain dup neg 620030 ft film 16mm X 100 reversal pan high speed 4028 roll film 35mm X 1000' type II Class J 800000 ft, (RFP 30-035-56-4454Q) $65 792

DeVoe Chemical Arts Inc. 1700 London Rd. Cleveland 12 Ohio film 24" x 30", photomechanical ortho 1000 pkg film 20" x 40" photomechanical ortho 240 pkg film 40" x 52" photomechanical ortho 48 pkg (RFP 30-035 56 4454Q) $107 189

Recordak Corp., 444 Madison Ave., N. Y. 22 N. Y. film 16mm x 200' microfile mfg processed, 7068 roll film 16mm x 200' microfile neg pan LSL 700 roll film 35mm x 100 microfile neg pan LSL 2589 roll (RFP 30 035-56 4454Q) $79 058

H. K. Porter Co. Inc. 10 Third St Joliet Ill. control electric power transfer, 698 ea. (RFP 30-035-56-4341Q) $489,-664

International Telephone & Telegraph Corp. Federal Telephone & Radio Co. Div. 100 Kingsland Rd. Clifton N. J., cable RF coax type RF—A/U spec MIL-C-17B, 98500 ft cable RF coax type RG59A/U spec MIL-C-17B 8500 ft, cable—RF coax type RG17A/U Spec MIL-C-17B, 005000 ft, (RFP-30-035-56-4069Q) $281,243

AMC, Wright-Patterson AFB, Ohio.

Benson-Lehner Corp. 2340 Sawtelle Blvd. W. Los Angeles, Calif. "BOSCAR" Model D reader computers 10 ea. (PR-G1204-892 and 1 and 2) $381 340

The General Tire & Rubber Co. 1108 Englewood Ave., Akron Ohio nose wheel assemblies 488 ea., (PR 671310), $88 907

Bendix Aviation Corp. Montrose Div., Montrose, Pa. transmitters pressure hydraulic type MJ-1, 480 ea. (PR PE-025888), $33 905

Kollsman Instrument Corp., 80108 45th Ave. Elmhurst N. Y. indicator rate of climb type AN5825T7 902 ea., (PR 535012) $62 248

Aircraft Radio Corporation, Boonton New Jersey radio receiver with dynamotor 402 ea. radio transmitter less crystals, 402 ea. spare parts test equipment and data list (PR PE 108010) $141 444

Bendix Aviation Corp. Red Bank Div., Eatontown N. J. generators 28 volt 400 amp DC 20 ea. (PR PE-035694) $92 534

Flight Research Inc. P. O. Box 1-F, Richmond 1 Va. motion picture camera, 16mm Model III 12 ea. motion picture camera 35mm model IV 12 ea. (MIPR R56-2424 162AER) $47 400

Standard Coil Products Corp., Kollsman Instrument Corp. 80108 45th Ave. Elmhurst, N. Y. sensitive air speed indicator Type L 7A 1490 ea., (PR PE-573504), $444 809

Sperry Rand Corp. Ford Instrument Co. Div. 31-10 Thomson Ave. Long Island City N. Y. indicator latitude and longitude ID 382A/ASN-6 100 ea. computers latitude and longitude CP 138A/ASN-6 61 ea. amplifier electronic control AM916/ASN 6 134 ea. (PR MA-528401 and MIPR R45-12s2-57 Arr) $154 005

Leland Electric Co., Dayton Ohio spare parts list (PR PE-038740) $61 420

Continental Motors Corp. Muskegon Mich. engines 0-205 (MIPR R56 7708 TCSMC-MDAP and Amend 1 2 and 3, R-56-7509-TCSMC MDAP and Amend 1, 2 and 3 R56 1188 TCSMC MDAP and amend 1 and 2) $61 114

Bendix Aviation Corp. Pioneer-Central Div. Davenport Iowa transmitter, rate of flow fuel type MA 2 2120 ea. (PR-035065), $377 284

Thomas A. Edison Inc. West Orange, N. J. transmitter pressure 980 ea. spares 240 ea. indicator pressure 980 ea. spares 240 ea. (PR 635010 and 635022) $327 188

Norden-Ketay Corp. 555 Broadway N. Y. 12 N. Y. indicator rate of flow, type F-1, 352 ea., (PR 575528) $186 542

Sundstrand Machine Tool Co. 2421 Eleventh St. Rockford Ill. transmission and governor assemblies constant speed drives, spare parts MT&TE and data, (PR PE-035616) $4 516 546

American Machine and Metals, Inc., United States Gauge Div. Sellersville, Pa. pressure transmitters type MS28005 5 1088 ea. (PR 035805) $110 194

Ford Motor Co., 3900 Schaefer Rd., Dearborn Mich. J-57-F-21 turbo jet engines, J57-F-21 turbo jet engines less afterburner, J-51-F-21 turbo jet engines, (PR 204558 and 708854) $70 482 315

United Aircraft Corp. Hamilton Standards Div. Windsor Locks Conn. materials and services for maintenance and support of B48F8A prototype propellers and related equipment (PR PE 672404) $718 102

Sperry-Rand Corp. Sperry Gyroscope Div., Great Neck Long Island, N. Y. technical data (PR 708274) $230,157

Breeze Corp., Inc. Union N. Y. starter generators type MC-1, 516 ea. (PR PE-036022) $307 201

J. B. Carroll Co., 310 N. Albany Ave. Chicago 12 Ill. computer air navigation, twilight, Type A 1 9250 ea. (PR MA-598750) $29 603

Eicor Inc., Chicago, Ill. alternator engine driven 120 volt single phase variable frequency 8 KVA, Mfg P/N 4205-1AS-1-11584, 200 ea. engineering data (PR SA-545020) $95 810

Molded Insulation Co. 335 E. Price St. Philadelphia Pa. connector plug U-94A/U 8000 ea. (PR 647808) $32 694

Color Corp. of America Houston Fearless Div. 11801 W. Olympic Blvd. Los Angeles, Calif. sinks, photographic processing type ES-2 330 ea. (PR MO-800052 MO-400615, MO-509921 MO-800001) $122 060

Bendix Aviation Corp. Utica Div. Utica, N. Y. starters, combustion P/N 38E20-7-D, 174 ea. (PR PE-673980) $524 100

Bendix Aviation Corp. Eclipse-Pioneer Div. Teterboro N. J. accelerated amortization (PR PE 705001) $50 591

Bill Jack Scientific Instrument Co., Solana Beach Calif. product improvement program for UCCS and SCCS (PR 030204 and 030204 1) $315 918

North American Aviation Inc., Los Angeles International Airport Los Angeles 45, Calif. modification of F 100A aircraft and flight test program (PR PA-202018 and PA-102089) $2 258 123

Boeing Airplane Co., Wichita Kans. seat ejection and canopy system trainers 5 (PR PH 205170) $33 331

Douglas Aircraft Co. Inc. Long Beach Calif. follow-on procurement of C-133A aircraft and supporting supplies, data and services flight tests radio trainers 4 nose section (PR 143563 236080 143673 236084 236087 236081 143774) $48 965,180

North American Aviation Inc. Los Angeles International Airport Los Angeles 45 Cal. performance of "super 7" flight test program on the F-100C aircraft (PR PA-220450), $103 960

North American Aviation Inc., International Airport Los Angeles Cal. modification of F-86F MTU PR PH-238012) $363,357

Convair General Dynamics Corp. San Diego Calif. F 102A Mobile training unit (PR PH 236063) $150 216

Convair General Dynamics Corp., San Diego Calif. F-102A aircraft spare parts and related items (PR PH 636329), $15 000.000

Lockheed Aircraft Corp., Burbank Calif. model TV 2 aircraft and supporting spare parts special tools and GHE and technical data. (MIPR R55-280-10-Arr) $1 500 000

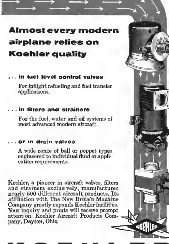
Lockheed Aircraft Corp. Burbank Cal. model T-1A aircraft aircraft spare parts special tools and GHE, (PR PH-143707) $10 552 852

Bell Aircraft Corp., Helicopter Div. Fort Worth Tex. model H-13H helicopters for the department of Army litter kits, (MIPR-R-56-600 TC) $3 211 102

Emerson Radio & Phonograph Corp., 14th & Cole Sts. Jersey City N. J. early warning radar trainer AN/APS-T4 engineering data maintenance data (PR 226710) $815 212

Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles 6 Calif., modification kit, extended facilities for AN/GPQ-T1 trainer maintenance spare parts engineering and maintenance data (PR PH-63r502) $800 000

Eitel-McCullough Inc. San Bruno, Cal. ceramic triode type CD-10 100 ea. ceramic pentode type CD 10 100 ea., (Contract Nr AF 33(601) 2176), $80,000



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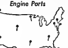

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Navy Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Navy Contracting Offices

AVIATION SUPPLY OFFICE, 700 Robbins Ave., Philadelphia 11, Pa.

Reliance Chemical Co., Lee Terminal-Standiford Field, Louisville 13, Ky., enamel (IFB 383 809 58) 42000 gals, $85 440

Van Brode Milling Co. Inc., Clinton, Mass., packet shark deterrent (IFB 383-724-781) 70080 ea., $97 230

Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J., nuts self locking (IFB-382-773-58) various $41 717

Bendix Aviation Corp., Red Bank Div., Eatontown, N. J., fan governor assy (383/2140 2381 F 4/3/52 Aero) 2780 ea., $27 718

Lear Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich., actuators (383/2110-851/52 383/2110 195/54 383/2110 46/55), various $65 895

North American Aviation Inc., Columbus Div., 1300 E. Fifth Ave., Columbus 16, Ohio, fuel tanks (383/330-298/55/Aero) various, $251 684

Airesearch Mfg. Co., Garrett Corp., 9851-9951 Sepulveda Blvd., Los Angeles 15, Calif., assys for various A/C (383/2110-1871/51 383/2110 1586/52 380/2112-182/54) various $47 288

The Emerson Electric Mfg. Co., 8100 Florissant Ave., St. Louis 21, Mo., armament parts, (383/2155-55 A 8/3/52) various $29 586

The Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, Ohio, brake assys (383/2150-1703X1/3/51) 170 ea., $40 497

Scintilla Div., Bendix Aviation Corp., Sherman Ave., Sidney, N. Y., distributor assys (382/2110 186/53) 617 ea., $154 177

Breeze Corp. Inc., 700 Liberty Ave., Union, N. J., ignition maintenance parts, (380/2110-82/53) various $105 065

Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., OMNI Directional instrument tester (PREN11 o124/58) various $73 407

General Motors Corp., Aeroproducts Operations, Municipal Airport, Dayton, Ohio, parts for actuators (383/2150 1217/52) various $156 908

Redco Tool Div., Red Lion Cabinet Co., Red Lion, Pa., test stands, (383/28283-3982/18 17/56) various $174 018

Air Associates, Inc., Teterboro, N. J., filter cap assys (382/2110-1870/51) 6072 ea., $88 120

Air Associates Inc., Teterboro, N. J., oil cooler actuators (383/2110-212/54) various $71 520

Jewil Electronics Inc., Belfield Ave. & Wister St., Philadelphia 11, Pa., control box testers (383/28009-151E2/5/58) 728 ea., $254 380

Bendix Products Div., Bendix Aviation Corp., South Bend, Ind., maintenance parts, (383/2110-1618/52) various, $115 894

Lear Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich., instruments for HSS 1 A/C (382/2120-669/51 388/2128 71/54), various $193 524

McDonnell Aircraft Corp., P.O. Box 516, St. Louis 3, Mo., spare parts for F2H A/C (383/2110 2059/A1/4/51, 383/2110 1798(A1) 4/51) various $120 341

McDonnell Aircraft Corp., P.O. Box 516, St. Louis 3, Mo., parts for F2H A/C (383/2110 1780/51) various $32 287

Goshen Rubber Co., Inc., 1525 S. 10th St., Goshen, Ind., gaskets (IFB 383 780 56) various $37 558

Conelec Products, Div. of Model Engineering & Mfg. Inc., North Lake St., Boyne City, Mich., indicators, (IFB 383 752-58) 2869 ea., $27 734

Atlas Paint & Varnish Co., 32-50 Buffington Ave., Irvington 11, N. J., enamel (JD-IFB-383-833-58) 25000 gals, $58 150

Belsiol Mfg. Corp., Bristol, R. I., boots flying (IFB-383-070-58) 11568 pr., $127,711

McDonnell Aircraft Corp., P. O. Box 516, St. Louis 3, Mo., parts used on F2H aircraft (383/2110-1779/51/AERO) various, $48 782

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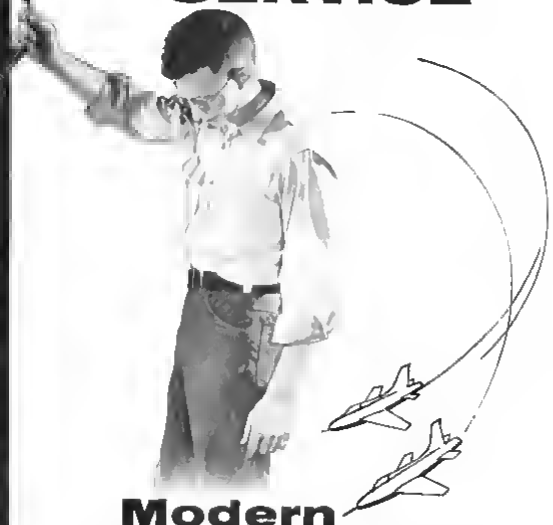

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St. Trenton N. J., parachute assy (383/26045 68G 3/4/56AERO) 1376 ea $225 - 564

McDonnell Aircraft Corp P. O. Box 516 St. Louis 3 Mo parts for F3H AC (83/8504 12/56) various $100 508

Hoover Electric Co. 2100 S. Flower St. Los Angeles 54 Calif actuator assy (383/2150 1407X1/3/52) 72 ea $37 800

The Goodyear Tire & Rubber Co., Inc. 1144 E. Market St. Akron 16 Ohio brake assys (383/3110-624/561, 340 ea $33 625

Breeze Corps Inc. 700 Liberty Ave. Union N. J. lead assys (383/2138-128 53) various $118 518

The Cleveland Pneumatic Tool Co 3781 E. 77th St. Cleveland 5 Ohio strut assys (383/2150-1127X1/3/51) various $118 844

Telephonics Corp Park Ave. Huntington L. I. N.Y. earphones, (383/2130 508-2/3/52) 12470 ea $41 881

Kollsman Instrument Corp. 80-08 45th Ave. Elmhurst 73 N. Y. kits for altimeters (383/20047-109X2/3/56) 11340 ea $37 583

Pesco Products Div. Borg-Warner Corp. 24700 N. Miles Road Bedford Ohio maintenance parts (383/2117-341/51) various $39 880

The Cleveland Pneumatic Tool Co. 3781 E. 77th St. Cleveland 5 Ohio fork assys (383/2150 1238/521 various $66 820

Publicker Industries Inc. 1429 Walnut St. Philadelphia 2 Pa. alcohol (IFB 383 827 561 various $86 042

Bendix Products Div. Bendix Aviation Corp. South Bend Ind. fuel control parts for jet A/C (383/2137-288/51) various $65 893

The Glidden Co. Chemical & Pigment Div. 1717 Summer St. Hammond Ind. copper pigment (165/180063F/56) 180000 lbs $107 676

Barber-Colman Co., Rockford Ill. actuators (383/9150 1418X1/3/51) various $20 506

Sundstrand Aviation Sundstrand Machine Tool Div. 2421 11th St. Rockford Ill. services & material (383/23055 22X3/56) 146 ea $160 428

Scintilla Div. Bendix Aviation Corp. Sidney N. Y. ejection seats (383/9314-179X5/4/51) various $58 023

The Standard Electric Time Co., 122 S. Broad St. Philadelphia Pa. electric timers (MIPR 09 603 6-38-106) 175 ea. $32 680

William Armstrong Smith Co. 109 E. Forest Ave. East Point Ga. paint (JD IFB 383 816 56) 15000 gal. $35 700

Reliance Chemical Co., Inc. Lee Terminal Standiford Fd. Louisville Ky. paint (JD-IFB 383-818-56) 57000 gal. $130 800

The Goodyear Tire & Rubber Co., Inc. 2144 E. Market St., Akron 16, Ohio brake assys (383/2110-1681/52/AERO) 3278 en. $700 507

The Goodyear Tire & Rubber Co., Inc. 1144 E. Market St. Akron 16 Ohio wheel brake and cylinder assys, (383/2110 1355/52 383/2110 1355/54 383/2110-32/55) various $903 924

Al Research Mfg. Co. Div. Garrett Corp. 9851-9951 Sepulveda Blvd. Los Angeles 45 Calif. air on-off valves for R4Y-1A/C (383/2150-1148/54) various $182 517

Cleveland Pneumatic Tool Co. 3781 E. 77th St. Cleveland Ohio trunnions (383/2150-1548X7/3/51) various $52 280

Cagle's Sportswear 115 Thomas St. Cape Girardeau Mo. flight jackets (JD-IFB 383-527-56) 6900 ea. $117 000

Manley Div. American Chain & Cable Co., Inc. 1100 East Princess St. York Pa. ordnance ground handling equipment (IFB 383 003 561 various $139 525

Penn Div. ACF Industries Inc., P.O. Box 200 Hyattsville Md. adapters (IFB 383-203 56) various $35 931

Arrowsmith Instrument Corp. 528 Reading Rd. Cincinnati 2 Ohio indicators (IFB 383 540-55) various $29 560

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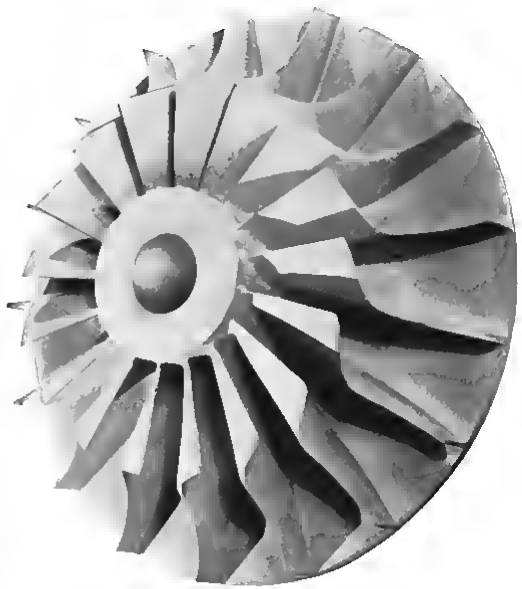

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Wexler Paper Products, 402 2nd Ave. N., Minneapolis, Minn., food packet, life raft aircraft individual (N600)62557) 41(21) (IFB 600-1017-56) spec MIL-F-15381A 256000 ea. $58,815

Goodyear Aircraft Corp., 1210 Massillon Rd., Akron 15, Ohio, airship gas pressure control instrument portable, 50 ea. drawings 86 sets (N600A) 41484) (IFB 600-602-56), $26,405

BUREAU OF YARDS AND DOCKS, 4th Naval District, U. S. Naval Base, Philadelphia 12, Pa.

Roscoe Engineering Corp. & Charles Rose, 1107 19th St., N.W., Washington, D. C., catapult and arresting gear development facilities, Naval Air Station, Lakehurst, N. J. (IFB NOy 91757), job $11,428,000

DISTRICT PUBLIC WORKS OFFICE, 11th Naval District, San Diego 38, Calif.

Hight Construction Co., 3448 Channel Dr., Ventura, Cal., construction of radio receiver facility, Naval Air Missile Test Center, Point Mugu, Cal., Contract NOy 91231 (IFB51370B) job $249,027

L. D. Richardson & Co., 9427 Santa Monica Blvd., Beverly Hills, Calif., construction of special project building No. 2, U. S. Naval Air Missile Test Center, Point Mugu, Calif. Contract NOy 90842 (IFB 49510B) job $240,183

NAVY DEPARTMENT, Bureau of Aeronautics, Washington 25, D. C.

Hughes Aircraft Co., Culver City, Calif., field engineering services by qualified electronics engineers in connection with the assembling, altering, repairing or operating or assisting or giving instructions with respect thereto of aircraft and electronic equipment, NOas 56-208s(MA38-4416-56), 48 man-months, $66,047

Bendix Aviation Corp., (Pioneer-Central Div.), Davenport, Iowa, turn and bank indicator, NOas 56-358-f(PD-42-1208-56) 493, $112,065

Flight Refueling, Inc., Friendship International Airport, Baltimore, Md., conduct an aerodynamic investigation of the hose element of the inflight refueling system and the hose drogue in-flight refueling system, NOas 56-752-c(AE-83-1840-56) $101,652

Interstate Engineering Corp., 2250 E. Imperial Highway, El Segundo, Cal., 20 mm gun charging system, NOas 56-472-f(AR-45-4083-56) 10, $28,500

National Research Corp., 70 Memorial Drive, Cambridge 42, Mass., conduct a study to develop a method of coating small particles of molybdenum alloy with a material with a low diffusion rate in molybdenum and preferably oxidation resistant, etc., NOas 56-491-c(AE-41-1833-56), $37,488

Bendix Aviation Corp., (Eclipse-Pioneer Div.), Teterboro, N. J., design, develop, fabricate and furnish light weight miniature Ne-Gimbal Lock vertical gyro transmitters, NOas 56-839-f(AE-73-1842-56), 3, $37,066

McKiernan-Terry Corp., Harrison, N. J., one set of shorebased spares for C11-2 steam catapult, NOas 56-578-f (S1-71-5826-56) $117,445

McKiernan-Terry Corp., Harrison, N. J., arresting engine Assemblies, Mark 7 Mod 2-3, NOas 56-405-f(S1-21-5912-56), 14, $1,843,682

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Army Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Navy Contracting Offices

REDSTONE ARSENAL, Huntsville, Ala

C T L, Inc., 516 W Fourth St Cincinnati 2 Ohio, research and development towards use of glass reinforced plastic materials for re-entry protection of ballastic missiles 1 job (Purchase Request No CS 12611-56) $166 341

The Murray Co., 1236 Spring St Atlanta Ga intercommunication system 1 system (Purchase Request No CS 12621-56 and CS 10316 56), $31 800

Arthur D. Little, Inc. 30 Memorial Dr Cambridge 42 Mass cryostat helium ADL Collins with accessories and services 1 lot (Purchase Request No CS 208-56) $75 676

CORPS OF ENGINEERS U S Army Office of the District Engr Albuquerque District P O Box 1538 Albuquerque N Mex

R D Lowman General Contractor Inc 1617 E Missouri St. El Paso Tex un manned gap filler facility (Schedules A B C & D) El Paso AF Station Texas Orla AF Station Texas Columbus AF Station N Mex. and Sierra Blanca AF Station Texas Contract No DA-29-005-ENG-1676 (IFB eng-29 005 56-63) job $239 488

Texas Turflog Co Box 666 Rockdale Tex., dust and erosion control (Schedule A) Walker AFB Roswell New Mexico Contract No DA-29 005 ENG 1676 (IFB eng-29-005-56-70) job $28 721

Robert E McKee, General Contractor Inc, 1918 Texas St El Paso Tex construction of missile assembly buildings, Holloman AFB Alamogordo N Mex Contract No DA 29-005-ENG-1677 (IFB eng 29 005 56 67) job $1 212 736

Robert E McKee General Contractor Inc., 1918 Texas St El Paso Tex construction of warehouse base bulk supply #1C supply and issue A I O building storage cold building #3A fire station crash and structure and kerosene tank and mogas tank underground Biggs AFB El Paso Tex contract No DA-29-005-ENG 1680 (IFB eng-29-005-56-48) job $406 967

CORPS OF ENGINEERS U S Army Office of the District Engineer Mobile Ala

National Tube Co Div of U S Steel Corp Pittsburgh Pa., steel storage tanks and mounting rack for Redstone Arsenal Huntsville Ala (Negotiated) $36 636

McDonough Construction Co. of Georgia Atlanta Ga construction of AF Family Housing at Hurlburt AFB Fla Contract DA-01 076-ENG 3328 (IFB ENG-01-076-56-251 job $3 315 143

Muncie Woodworking Co East Brewton Ala construction of unmanned gap filler facility at Eglin AFB Fla Contract DA-01-076 ENG 3329 (IFB ENG-01 076-56 011 job $32 000

CORPS OF ENGINEERS, U. S. Army, 237 Fourth Ave, Huntington West Va

Joseph Skilken & Co. 381 S Third St., Columbus Ohio construction of flight simulator training building at Lockbourne AFB, Ohio Contract No DA 46-022 ENG 2261 (IFB ENG 46-022-56 18) job, $107,462

CORPS OF ENGINEERS U S Army, Office of the District Engineer Jacksonville District 575 Riverside Ave, Jacksonville Fla

Trumbull Construction Co, 8 12th St. Midland Pa erection of Gantry Crane WS-315 A project AFMTC Patrick AFB Fla Solicitation No ENG-08-123-(Neg-56-7) job $142 022

LOS ANGELES ORDNANCE DISTRICT 55 S Grand Ave Pasadena 2 Calif

Harvey Machine Co. Inc., 19200 South Western Ave Torrance Cal sets components for 2 75 rocket T131 job $44 987

CORPS OF ENGINEERS U S Army, 4735 East Marginal Way Seattle 4 Wash

Campbell Construction & Equipment Co., 1150 Folsom St San Francisco Cal F 07, F 37 F 45 and F 87 control and launching areas, Fairchild Defense Area Wash Contract DA 45-108-ENG 2664 (IFB ENG-45-108 56 134) job $3 648 302

Lindbrook Construction Co 11735 35th N E Seattle Wash Taran Fairchild AFB Wash Contract DA-45 108 ENG 2672 (IFB ENG 45 108 56-1__) job $31 282

CORPS OF ENGINEERS U S Army, P O Box 2191 Tullahoma Tenn

Allis Chalmers Mfg Co., 624 Hamilton National Bank Bldg Chattanooga Tenn Contract No DA 40-126-eng-231 furnishing equipment for ninth stage centrifugal compressor and compressor drive system gas dynamics facility Arnold Engineering Development Center Tullahoma Tenn (IFB ENG 40-126-56-23) job $240 280

CORPS OF ENGINEERS U S Army 575 Riverside Ave., Jacksonville Fla April 27

Empire Gas Engineering Co 7 Baltimore Place N W Atlanta Ga construction of gap filler facilities, Bunnell Winter Garden & Inverness Fla., (Inv ENG 08-123-56-62) job $167 645

Fairbanks, Morse & Co. 600 S. Michigan Ave, Chicago Ill furnishing five 5000 GPM pumps with diesel engines and accessories to AFMTC Patrick AFB Fla, (Negotiated) job $226 020

Noble Co. 1650 Seventh St Oakland 26 Cal, furnishing and installing bridge cranes for missile assembly buildings K L and M WS-107A project AFMTC Patrick AFB. Fla. job $402,600

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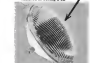

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Other G-E Taxiing Lamps are available for use in either 28 or 13 volt aircraft electrical systems, and in a variety of wattages and bulb sizes There's one just right for any taxiing assignment Your G E Lamp Distributor can supply a full line of G E Taxiing Lamps or any other type of lamp for aircraft lighting.

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First Field Clinic Covers Icing, Brakes

By Erwin J. Bulban

Teterboro Airport, N J—Following a growing trend by manufacturers in the aircraft industry to establish stronger distributor factory-customer ties, B F Goodrich Co last week presented the company's first field clinic for corporation pilots

Gone into thoroughly during the technical forum was complete information regarding Goodrich products including the many "do s and don ts" regarding their use The program was presented in co-sponsorship with Airwork Corp, Millville, N J, one of Goodrich's distributors, and Atlantic Aviation Corp an Airwork Class A dealer at the latter s Teterboro Airport Executive Aircraft Center

The half day session covered de-icers, brakes tires and other equipment for business planes

Need for De-Icers

Studies by the U S Air Force and National Advisory Committee for Aeronautics indicate that ice encounters will average approximately 2% of flight time on a year-round basis on air routes in the continental United States, Wayne K Heimann, De-Icer Technical Section manager, told the pilots The Air Force s investigation is aimed at determining the probability of ice encounter aloft within any five-degree block of latitude and longitude in the entire northern hemisphere Preliminary findings are in Wright Air Development Command T N 55-225

NACA s program is designed to provide data expressing ice encounter time as a per cent of flight time

For best results, a de-icer should be turned on when the ice layer reaches a thickness from one quarter to one half inch thickness The de icer equipment should be operated only as required, continuous operation will only shorten the life of the boot For optimum service an ice detection probe, about four inches long and three eighths inch thick, can be installed in the plane's nose The detector will sense ice buildup and can be rigged either to flash a light in the cockpit signaling the pilot to activate his de-icers, or to operate the equipment automatically

Lockheed L 18 Lodestar and PV 1 Ventura operators will soon be able to obtain the new Type 21 de-icing boots for their airplanes Type 21 is similar to the much-used Type 11 in having spanwise inflation tubes. It features attachment to the wings with an air-curing cement instead of with Rivnuts and fairing strips The trailing edges of the Type 21 de icers are faired The multiple tubes are three-quarters to one one quarter inches wide instead of the Type 11's two to-three inches The later models also operate under higher air pressures—from 15 to 22 psi compared with 7 to 9 for the Type 11 Inflation by means of solenoid valves near each de-icer section provides almost instantaneous expansion of the boots Planes already using Type 21s include the Beech 50 Twin Bonanza, Cessna 310, Aero Commander and Learstar

A variation of the Type 21 is Type 22, which has tubes running chordwise to provide minimum aerodynamic effect when inflated Installation is limited to applications where the de-icer width is greater than 22 in Type 21s are for high speed aircraft and are on the 1049G Super Constellation and are scheduled for the 1649 Super Connie

A new cement for attaching the Type 21 and 22 boots has cut installation time from 24 hours to just one hour Another problem solved was the difficulty in removing the earlier cement, the new type is a one part formula easily taken off by using Toluol

Brake Developments

New brake developments underway at Goodrich research centers were previewed by sales engineer Ralph G Heberding, who cautioned that these still were some time off as far as corporation pilots were concerned But he indicated what can be expected in the future Among the new items

• Liquid-cooled brakes A new B. F Goodrich development, tested in the laboratory for two years, "is the first that really works," Heberding stated The first test installation is now being made on a military airplane and the company expects to have the liquid-cooled brake in production for the new highspeed transports being ordered by the airlines

"This is a brake system, not just a brake," Heberding noted Although he declined to go into detail, he indicated that braking heat is not stored in the wheel and high temperatures in the wheel cavity are prevented

In a comparative laboratory test between the new brake system and two standard expander type brakes, a load developing 28 300 000 ft lb of kinetic energy was applied, involving stopping a 150 000 lb airplane traveling at 163 mph

The dual installation expander brakes theoretically stopped the airplane in 43 5 sec a single unit liquid brake system in 26 9 sec At the end of the test, personnel could put their hands on the liquid cooled brake

Other features Much longer lining life compared with standard brakes, high response and no indication of

Super Cub Airlifts Ranch Fences

Pre-stressed concrete fence posts are attached to bomb-racks under the wing of a 150 hp Piper Super Cub in New Zealand to be dropped at a fence erection site on a large sheep ranch The plane also will drop coils of barbed wire This Super Cub is fitted with a chemical hopper behind the front seat for spraying and dusting

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fade. In addition the system is said to be a smaller package than conventional brakes.

• **An automatic brake adjustment** device also is in the works to relieve plane owners from periodically checking their systems.

• **New linings** are being developed by Goodrich in conjunction with lining manufacturers to withstand higher temperatures and provide higher torque in a smaller package.

• **New brake actuation methods** permit tug operation at higher temperatures and lower displacements than the current expander-tube type are being studied. One method, using an automatically adjusted piston, is past the development stage. Another actuation method uses a metal capsule or bellows has no organic parts and is said to be a simple design.

Lodestar Expander Brakes

Goodrich introduction of an expander tube brake approximately a year ago for the Lockheed Lodestar and Learstar has made some headway on corporation airplanes, with Owens Corning, Forrest Oil, Continental Can, Gulf Oil and Columbia-Geneva Steel being among its customers.

Modification kits have been made available. Kit No. B 191 118 for conversion of Lodestar wheels and brakes lists at $2,152.62. The installation requires a rework of the Lodestar strut torque flange, which can be done by Cleveland Pneumatic Tool Co., or Cleveland Aero Products at approximately $250 per strut, or the strut drawing can be furnished to CAA-approved repair stations qualified for such work.

Total cost of the complete conversion runs about $2,652.62 and the complete installation weighs approximately 191.25 lb. Delivery of the equipment takes 30-45 days.

Pilots whose planes have expander-tube brakes were cautioned not to set the parking brake immediately after a hot stop or after a longe period of taxiing during which brakes were frequently used.

Advice was to chock the wheels and allow the brakes to cool before applying the parking brake.

Setting the brake while it is still hot permits heat to be conducted to the rubber expander tube. Also, the drum probably has expanded from the heat, when it cools and contracts, the pressure may be too much for the tube, which is expanded by fluid.

Tire Hints

The dimpled-tread tire is superior in most instances to the standard rib tread design, a Goodrich spokesman indicated, particularly in providing more efficient load distribution on the tread and in lessening exposure to cutting by sharp stones, especially the flint-like material found at high-altitude airports. Cutting in many cases is the major factor in reducing tire life. One major airline reported that it experienced 47% more tread life from dimpled tires than the rib-tread type used previously.

Although the dimpled tread appears to present a smoother surface than the rib tread, indicating lower skid resistance, there actually is very little difference between the two in this respect, he stated and the company has had no complaints from its airline customers regarding the skid characteristics of the dimple type.

The company indicated that although the USAF and Navy are sold on the superiority of tubeless tires, it has not yet found a practical market for these in the corporate plane field. High costs of converting wheels to take the tubeless tire is believed to be the major deterrent.

This market's future probably will increase as business plane manufacturers standardize for tubeless tires on new planes.

Beech Aircraft Corp., for example, recently revealed that it is making Goodyear nylon tubeless tires standard equipment on its Super 18 twin-engine transport (AW June 11, p. 115).

A Goodrich representative reported that the company had complaints from customers about tires developing flat spots after very little use. Upon their return to the factory, however, the tires were found to be satisfactory. The source of trouble was traced to the plane's standing for extended periods in cold areas, causing the nylon cords inside the tire to temporarily set in a flattened arc, building a flat spot. The simple cure: taxi the airplane around a little, the spot will disappear.

Another complaint was a lacy fringe along the edges of a tire's veneers which looked like a ply separating. This 'lace' is harmless, just trim it off, the Goodrich representative stated.

Goodrich representatives commented that this initial corporation pilots' technical forum has not been set up on a definite schedule, but they are interested in staging it elsewhere providing their distributors co-sponsor the presentation, as did Airwork.

New England Outlet Gets First Skimmer

Delivery of the first production three-place Skimmer amphibian will be made by June 29th by Colonial Aircraft Corp., Sanford, Me. The initial plane is going to the company's New England distributor, Huck Aircraft Corp., Green-

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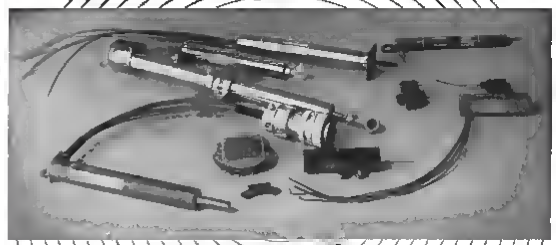

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wich, Conn., one of eight outlets franchised by Colonial.

The manufacturer is producing an initial lot of 10 airplanes; will start a second run of parts for 10 additional planes in about a month. The shoulder wing all-metal Skimmer, powered by a 150 hp. Lycoming pusher engine, sells for approximately $15,750. Addition of some 35,000 sq. ft. of production area to the firm's present facility will provide a total of 53,000 sq. ft. of manufacturing, assembly and flight test space. The company has been granted a $60,000 loan by the Small Business Administration to be used as required to accelerate production. Payroll now totals 60 employees; this is expected to increase to 90 by November.

In addition to Huck Aircraft, these other distributors have been chosen by Colonial: Frontier Distributors Inc., Spenard, Alaska; Lund Aviation (Canada) Montreal Airport P.Q.; National Aero Sales Corp., Chicago, Ill.; Jack Straten, Inc., New York; Amphibions Aircraft, Inc., Ft. Lauderdale, Fla.; Louisiana Aircraft, Inc., Baton Rouge; and Eternitas Corp., C. A., Caracas, Venezuela. Sales outlets are being negotiated for the Pacific Northwest and Chesapeake Bay areas and several foreign countries.

Beech Business Plane Sales Jump 26% in 1956

New records in business aircraft sales to its distributor-dealer organization are reported by Beech Aircraft Corp., Wichita, Kans. During the first eight months of its current fiscal year—October through May—Beech commercial sales totaled $17,740,781, an increase of more than 26% compared with the same period in Fiscal 1955.

The company also notes that months of April and May set new single months records in business plane sales in Beech's 24-yr. history, sales being $2,868,509 and $2,892,288 respectively.

As of May 31, the company's total commercial and military aircraft products backlog exceeded $83 million.

PRIVATE LINES

Civil Aeronautics Administration has issued an aircraft engine specification (E 286-1) providing these pertinent details on Lycoming's new O360 A1A engine: Bore and stroke is 5.125 x 4.375 in., giving 361 cu.in. displacement; weight dry is 282 lb. Compression ratio is 8.6-1. The four-cylinder horizontally-opposed aircooled engine delivers 180 hp. at 2,700 rpm. on takeoff; a like power at maximum continuous power rating at sea level. The new O360 is fitted in the prototype Piper PA-24 Comanche (AW June 11, p. 109).

New York State has 272 landing facilities, nine more than it had last year; a new airport directory available from the State Department of Commerce reveals. There are 45 municipal fields, 168 private and commercial, 11 military, 38 seaplane bases and 10 heliports. For the first time all 37 unmarked N.Y. State Thruway interchanges are identified. Unmarked communities total 726. Free copies of the map are available on request from the department's office at 112 State St., Albany 7, N.Y.

Air race events scheduled in the U.S. this year: July 7-8, Municipal Airport, Niagara Falls, N.Y.; July 14-15, Pittsburgh, Pa. (airport to be announced) and Aug. 4-5, Winnebago County Airport, Oshkosh, Wis. All competitions are for "midgets"—planes designed to specifications laid down during former Goodyear and Continental Trophy Races. Counting a race last May, the four events planned this year show a marked uptrend in the number of races that have been held in recent years.

Civil Aeronautics Board has extended deadline for comments on its proposed revision of aircraft registration markings (SR 412). Larger markings were sought placed on the sides of the fuselage or vertical tail to aid Air Defense Command interceptors in identifying civil aircraft. USAF claimed that then planes often had to slow down to less than safe maneuverable speed to read current small markings on tail. CAB now proposes to require larger markings after Jan. 1, 1960 and invites industry and aircraft owner comments.

VHF plane communications transceiver DTR 18/36 operates on 180 or 360 channels with frequency coverage of 118 to 135.95 mc. The transmitter provides 15 watts power output on any channel. Unit is built on a ½ ATR rack and weighs 22 lb. It can be supplied for use as a simplex unit or for cross channel communications. Price for 180-channel simplex operation, including shock mount is approximately $2,500. Manufacturer of the equipment is Dare, Inc., Troy, Ohio.

Correction: An item in this column, June 4, p. 103 reported that up to 60 lb. of dirt had been taken out of a DC-3 business plane during cleaning prior to weighing. The Safe Flight Instrument spokesman reports that this should have read "...out of DC-6 type aircraft."

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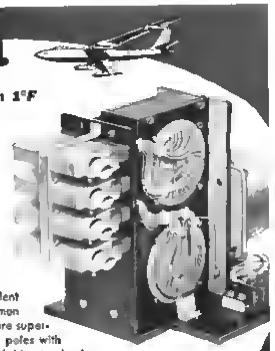

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CAB Accident Investigation Report:

PanAm DC-7B Engine Lost Near Venice

A Pan American World Airways DC-7B N 776PA lost No. 3 powerplant because of engine fire while in flight near Venice, Italy, on December 28, 1955, about 1930.[1] The aircraft returned to Rome, its last point of departure, and landed without further difficulty. The 42 passengers and six crew members were not injured.

Pan American World Airways Flight 65 of December 28, 1955, originated at Teheran, Iran, for New York City with several stops scheduled including Rome, Italy, and Brussels, Belgium. (Brussels was a temporary replacement stop for Paris, France.) The flight segments from Teheran to Rome were routine. Flight 65 departed Rome at 1818 on an IFR (Instrument Flight Rules) flight plan to Brussels which specified a cruising altitude of 19,000 feet.

The crew of six consisted of Captain A. D. Reedy, First Officer W. J. Box, Third Officer J. B. Sorenson, Flight Engineer L. C. Thayer, Purser Miss Artha Grubb and Stewardess Miss Etta Fredin. A navigator (second officer) was not required or carried on the flight. Cruising altitude was reached without incident at 1842 and the flight proceeded in clear weather.

At 1912 No. 3 engine and propeller overspeeded and the tachometer needle swung rapidly past the highest calibration, 3,200 r.p.m., to full deflection where it remained. The captain immediately reduced power on all engines, then disengaged the auto-pilot and the flight engineer attempted to feather the No. 3 propeller without success.

At the same time the copilot noticed a momentary flicker of the fire warning light for the power section of No. 3 engine. Air speed was reduced from 200 knots to 140 knots and descent was started. The first officer, who had been in the cabin, came forward and reported a fire in No. 3 engine. As No. 3 propeller was windmilling at a high speed, an attempt was made to "freeze" the engine by shutting off its oil supply. Accordingly, the firewall shutoff valves were closed. One bank of CO_2 was discharged which reduced the intensity of the fire but did not extinguish it. The second bank of CO_2 was temporarily held in reserve.

Feathering Button Depressed

During these actions the flight engineer was intermittently depressing the feathering button. The discharge indication on the ammeter showed the feathering motor to be operating but the propeller did not feather and continued to windmill as before.

Fire warnings were still lacking in the cockpit with the exception of the momentary flicker immediately following the overspeeding.

Zone 2 and zone 3 fire warnings from Number 3 engine then appeared. This was followed by increased fire at the No. 3 engine area whereupon the second bank of CO_2 was discharged to that engine. The red warning lights and aural alarm still operated after this second use of CO_2. About this time the flight engineer noticed an intense white fire through a rupture in the cowling near the air scoop of No. 3 nacelle.

The beach and flat shores of the Adriatic Sea near Venice, Italy, were visible in the moonlight from the flight's altitude of 5,000 feet.

It was decided to make an emergency landing on or near the beach and Rome radio was so advised. The aircraft descended to 500 feet and at this altitude, after a series of bright flashes and severe vibration, the burning No. 3 engine fell free of the aircraft. The aircraft then went below 300 feet and severe buffeting occurred with the airspeed dropping abruptly to about 90 knots. Power was applied to the remaining three engines and an airspeed of 140 knots and a climb of 150 feet per minute were soon established.

A visual inspection revealed the fire to be extinguished with no apparent damage to the wing. The use of 10 to 15 degrees of wing flap reduced the existing buffeting. A further check indicated that the aircraft was capable of continuing flight and Rome was advised of their intention to return. The aircraft was then climbed to a cruising altitude of 7,000 feet and the flight proceeded to Rome where it landed at 2040.

Weather conditions were clear throughout the area that was flown by Flight 65.

INVESTIGATION

A shepherd observed the still burning engine on the ground near Venice and notified State Police who guarded the engine and propeller until arrival of PAWA personnel.

After photographs were taken these components were trucked to Rome for examination and subsequent shipment to PAWA's maintenance base at New York.

The propeller governor had not been damaged by fire and after an initial examination this component was flown to the United States. At the Hamilton Standard factory it was disassembled under the supervision of Board investigators.

Disassembly of this governor, model 5U18-66P3, serial No. 76400, revealed a fatigue type failure of the governor drive shaft, part No. 67035U, initial failure extended through the web between two of the high pitch oil ports with resulting failure occurring to the drive shaft through the remaining webs. The fracture line passed through one or more quench cracks at the port webs. Total time on the shaft was 407 hours when the failure occurred.

Examination of the remainder of the governor revealed that broken parts of the shaft had blocked oil ports which effectively prevented feathering of the propeller.

Four Others

A review of past governor drive shaft failures of this type revealed four others that occurred during October and December 1955. All of these were in the same type engines and DC-7B's. Further, all were similar in that a fatigue failure occurred at the corners of the rectangular high pitch ports in the shaft. Total times on all of the failed shafts were between 375 and 592 hours.

As a result of these failures, Hamilton Standard had revised its heat treating procedures to reduce quench cracking. All governor drive shafts in service were returned for replacement with those having the improved heat treatment. The letter "U" after the part number (67035) on the drive shaft involved in this accident indicates that this replacement had been accomplished.

In November 1955 all DC-7B operators were advised by the propeller manufacturer that as a result of the failures a program was being initiated to replace all governor drive shafts bearing the part number 67035 with a new shaft, part number 321822. This new drive shaft incorporates elliptical high and low pitch ports in place of the rectangular ports thereby eliminating stress concentrations in the corners. All PAWA DC-7B's are currently being equipped with the 321822 drive shaft and an r.p.m. sensitive hydraulic pitch lock[2] in the dome assembly. This replacement program was established by the manufacturer with priority given to governors having less than 1,000 hours. Those with over 1,000 hours of use were considered to be airworthy.

Replacement Mandatory

On January 16, 1956, the Civil Aeronautics Administration issued Airworthiness Directive 56-2-2 making mandatory the replacement of propeller governor drive shaft 67035 with governor drive shaft 321822 on all DC-7 aircraft.

The manufacturer is producing a newly designed drive shaft which increases the web strength between the ports by 50 percent. The new shaft, part number 321841, has four oval ports at the high and low pitch positions thereby increasing the web size between the ports.

An examination of the No. 3 engine at New York indicated that its operation, prior to the shaft failure, had no bearing upon the difficulties encountered by Flight 65.

The examination also indicated that

[1] All times referred to herein are Greenwich mean; altitudes are mean sea level.

[2] A device to prevent blade movement toward low pitch if the r.p.m. reaches a preset value.

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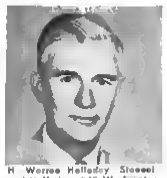

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as a result of overspeeding the engine impeller assembly failed and damaged the rear engine case to an extent that the fuel injection lines in the case were broken. This undoubtedly allowed fuel to escape, resulting in severe fire. There was no apparent maloperation of No 3 engine prior to the drive shaft failure.

ANALYSIS

The engine impeller assembly must have disintegrated centrifugally, throwing metal particles outwardly through the cowling through which was seen the intense white fire; this failure also accounted for the severed fuel lines that provided a source of fuel for the fire.

The reason for the failure of the fire warning system to function properly could not be determined because of damage to the system during the fire and the tearing away of the engine and propeller. However, in this case there was no delay in applying emergency measures because of alertness of the crew member in the cabin at the time of the overspeeding.

It is very apparent that a serious accident was barely averted. Had the flight reached higher terrain on course a descent as made, would not have been possible. Alertness and good judgment, under extreme emergency, are strongly reflected in the crew's conduct.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The company, the aircraft, and the crew were currently certificated.
2. The gross weight of the aircraft at takeoff was under the maximum allowable.
3. The governor drive shaft of No 3 propeller failed in flight causing the engine and propeller to overspeed.
4. No 3 propeller could not be feathered because broken fragments of the drive shaft blocked oil ports of the feathering system.
5. High speed windmilling continued and the engine impeller failed centrifugally, severing fuel injection lines and oil passages, a severe engine fire ensued.
6. The fire could not be extinguished and the engine and propeller fell free.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was failure of No 3 propeller governor drive shaft which resulted in overspeeding, inability to feather the propeller, an engine failure, fire, and inflight loss of the No 3 powerplant.

By the Civil Aeronautics Board:

/s/ James R Durfee
/s/ Joseph P. Adams
/s/ Chan Gurney
/s/ Harman D Denny

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident on December 28, 1955. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended.

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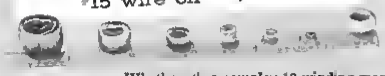

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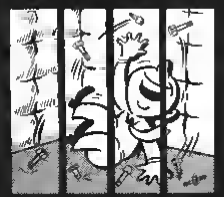

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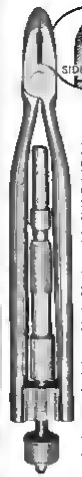

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Flight Personnel

Captain A. D. Reeds, age 43, held a valid airman certificate with an airline transport rating and DC-7, B-377, L-49, and 749 equipment ratings. He had a total of 13,972 flying hours, of which 366 hours were in DC-7 aircraft.

First Officer W. J. Box, age 34, held a valid airman certificate with airline transport rating and DC-4, DC-6 and DC-7, and L-49 and B-377 equipment ratings. He had a total of 11,704 flying hours, of which 307 hours were in DC-7 aircraft.

Third Officer J. B. Sorenson, age 24, held a valid airman certificate with commercial pilot single and multi-engine land and instrument ratings. He had, in addition to other time, 29 hours in DC-7 aircraft.

Flight Engineer L. C. Thayer, age 43, held a valid airman certificate with flight engineer aircraft and engine mechanic ratings.

He has 6,952 hours of flying time, of which 311 hours were in DC-7 aircraft.

Miss Arth i Gruhl was employed by the carrier on July 20, 1953. She was acting in the capacity of purser on the flight.

Miss Eva Fredin was employed by the carrier on October 3, 1955, and was acting in the capacity of stewardess on Flight 65.

The Aircraft

Douglas DC-7B, N776PA, manufacturer's serial No. 44870, was delivered to Pan American World Airways on August 19, 1955.

Total flying time since manufacture was 1,224 hours. The aircraft was powered by four Wright model TC9718DA4 engines. Time since overhaul on Nos. 1, 3 and 4 engines was approximately 200 hours each; No. 2 engine had 306 hours since new.

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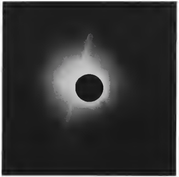

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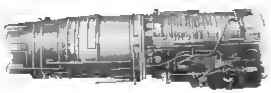

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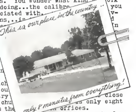

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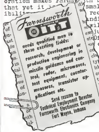

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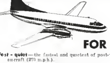

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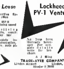

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LETTERS

Thumper Defense

In an article in your issue of April 9, 1956 (page 44) entitled 'Effective ICBM Defense Possible Under Present State of Art,' I was surprised to learn that " ... General Electric's Project Thumper (MX795) —concluded that defense against even as elementary a weapon as the V-2 was technically beyond reach.

During the life of the Thumper Project the writer served as project engineer. The targets were the long-range missiles which might then (1946-1949) be anticipated in the near future.

The conclusions were summarized in the final report as follows:

'The Thumper problem is a difficult one but not impossible. A practical engineering solution can be achieved not as a result of some new and startling technique, but through the improvement of existing techniques. The system which has evolved may not be the ultimate one, but it is the one which is a feasible first step based upon available techniques and a reasonable period of development.'

ALBERT O. DODGE
Instrumentation Analysis and Requirements Engineering Operation
General Electric Company
Special Defense Projects Department
Schenectady 6, N. Y.

Supports Editorials

On the page that is devoted to letters from readers of your AVIATION WEEK it is stated that AVIATION WEEK welcomes the opinion of its readers on the issues raised in the magazine's editorial columns."

Often your editorial column is devoted to discussing the airpower of our United States of America which editorials I remove from my copies of AVIATION WEEK for my files.

Examples of the editorials I am referring to are those of January 9 (Are We Losing the Missile Race?), 23 (The New Airpower Fraud), and 30 (Airpower's Year of Decision), February 13 (Clarification on the B-52 and Quarles on Policy), April 9 (Airpower Budget Issues Are Clear), and 30 (Research Policy Needs Revision), and May 7 (Wilson's Record on Airpower).

I would like to commend you and your AVIATION WEEK for your editorials such as the above ones. It is my conviction that the citizens of our Country should praise and thank individuals such as you and magazines such as yours for your attempts to present the truth concerning our nation's airpower. It will be through editorials such as yours that it may be possible to force the Administration and Congress of our Federal Government to provide our Country with adequate national and civilian defense.

The issues of AVIATION WEEK that I receive through my subscription to your magazine have been particularly useful to me during the past few months. A few months ago I announced my candidacy to become the United States Senator from the State of California, and therefore I will be on the ballot in the June 5, 1956 California Primary Election. During the campaign the information and editorials of AVIATION WEEK have been very helpful to me.

One of the major reasons for my being a candidate is my complete and absolute disgust for the manner in which the Administration (especially the Defense Secretary) and Congress are handling our National (especially airpower) and Civilian Defense Programs.

While I am a Republican candidate (am also a member of the Republican State Central Committee of California), as Senator from California I will work for adequate National and Civilian Defense Programs. And I will follow this policy even if it is in conflict with the programs and policies advocated and followed by either or both the Republican and the Democratic parties. It is my conviction that the welfare of our country and its citizens comes before the welfare of any political party.

It is my belief that my experience in the aircraft and guided missile fields will provide me with the necessary background to work for an adequate Defense Program. Currently I am employed as a senior research engineer in the area of weapon systems analysis and operations research. Have also worked in the areas of aerodynamics, design, liaison engineering, flight test, planning and general staff work on aircraft, guided missiles and general ordnance.

In conclusion I would like to again commend you and your AVIATION WEEK for your editorials on our Nation's Airpower. Please continue to bring to the attention of our citizens the truth and needs of our Nation's Airpower.

RAYMOND R. PRITCHARD
Pomona, California

(Raymond Pritchard was defeated in the California Primary Election by Sen. Kuchel —Ed.)

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

You're Welcome

We are interested in reproducing your very comprehensive articles on Single Sideband, which appeared in the April 30 and May 7 issues of AVIATION WEEK for distribution to airline committees interested in these developments.

We will appreciate it if you can arrange permission to use these excellent summary articles to facilitate our work.

C. A. PETRY
Director, Technical Services
Aeronautical Radio, Inc.
1700 K Street, N.W.
Washington, D. C.

Helicopter Facilities

A poignant editorial in a recent issue of AVIATION WEEK stated that helicopter design lags behind need. It was stated that there was high enthusiasm for the potential of the helicopter among short haul airlines, but where was the equipment? It was stated that the answer must come from the military services who have the role of sponsoring angels of technical developments that may make the commercial potential pay off. It goes without saying that the military services would benefit enormously by the same pay off. And finally the citizen taxpayers would benefit in terms of commercial service, military security and true value received for procurement dollars.

In general it appears that the military services have done a good job in backing meritorious helicopter projects of all kinds as evidenced by the numerous experimental configurations that have appeared during the past ten years. It becomes a matter of vital importance then to determine why the helicopter is slow to achieve commercial maturity.

As an engineer who has had experience in different major corporations designing respectively airplanes, jet engines and helicopters, it is my observation that the helicopter industry as a whole has been operating at a considerable disadvantage as compared to the airplane and jet engine industries. This disadvantage resides in the almost complete lack of laboratory facilities within the helicopter industry. At the other extreme, the major jet engine companies can not operate without development laboratories valued at 20 million dollars or more. These big complete laboratories are paid for by the military either directly or by delayed bookkeeping, it appears.

The helicopter industry relatively is as poor as a church mouse as far as development facilities. No wonder technical refinements are slow in coming. All of the elements of the helicopter need refinement component by component. This can only be done by a systematic evaluation and convergence in the laboratory such as is done for every military jet engine.

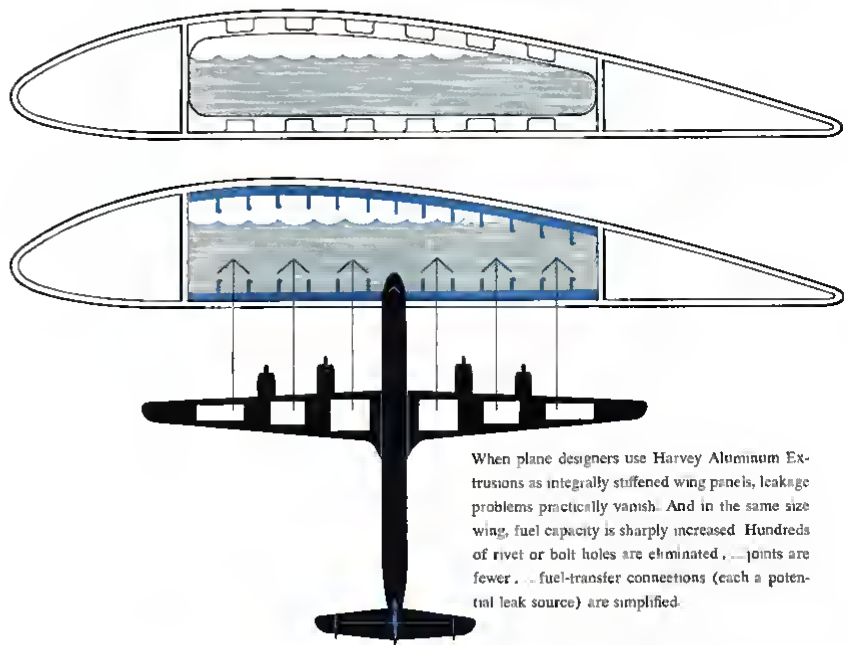
Jet engine laboratories were set up under the urgency of war clouds and the hydrogen bomb threat. The same urgency should have dictated the erection of development laboratories within the helicopter industry in order to speedily resolve the numerous unique problems within the industry. In the last analysis the only true protection from hydrogen bombs is distance or the dispersion of people and targets. Only the helicopter has the weight carrying capacity and potential ability to do many jobs efficiently and economically in this atomic age of deconcentration. The development of the helicopter should keep pace with the development of the jet engine and guided missile.

It seems imperative that the helicopter industry and military services join forces in establishing helicopter development laboratories and in fostering advances in the art at the fastest possible rate.

C. W. RANSON

Harvey extrusions...
for safer flight,
greater fuel capacity,
simpler construction

Fuel leakage in aircraft wing tanks *must* be eliminated at all costs... it's one of flying's greatest dangers. Manufacturers once had to resort to elaborate sealing procedures around every joint and rivet. But even then, normal flight operations and wing flexing would eventually cause leaks, and locating them was a giant-sized maintenance headache.



When plane designers use Harvey Aluminum Extrusions as integrally stiffened wing panels, leakage problems practically vanish. And in the same size wing, fuel capacity is sharply increased. Hundreds of rivet or bolt holes are eliminated... joints are fewer... fuel-transfer connections (each a potential leak source) are simplified.

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